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WATER PRICING AND ALLOCATION WITH PARTICULAR REFERENCE TO CALIFORNIA IRRIGATION DISTRICTS

Michael F. Brewer

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WATER PRICING AND ALLOCATION WITH PARTICULAR REFERENCE TO CALIFORNIA IRRIGATION DISTRICTS

by

Michael F. Brewer[1]

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1/ Assistant Professor of Agricultural Economics and Assistant Agricultural Economist in the Experiment Station and on the Giannini Foundation, University of California, Berkeley, California.

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WATER PRICING AND ALLOCATION WITH PARTICULAR REFERENCE TO CALIFORNIA IRRIGATION DISTRICTS

I. THE PROBLEM AND ITS PERSPECTIVE

Public water districts have a primary function of acquiring and providing their members with a water supply. When this supply is employed in production processess-such as irrigated agriculture--its disbursement becomes the allocation of an economic good. No economic problem may arise until the entire supply of district water holds value for such production processes, and the limited supply must be allocated among competing uses. The problem of pricing and allocation is manifest in the administrative procedures that establish a district "price" for this water. The quantity and timing of individual member demand for water from a district will be determined on the basis of the particular "price" that is established and its relation to the costs of acquiring water from other sources.

Payments by members for water supplied constitute the principal source of revenue to many public water districts. These payments must provide sufficient receipts for annual outlays consisting largely of the retirement of bond issues used to finance development and conveyance structures or obligations under contract with the federal government. The types of obligations incurred by the district have a bearing on the nature of total outlays and on the proportion of such fixed obligations to outlays required for current administration and operation. This may have an important bearing on the necessary pattern of receipts and thus be reflected in the "price" of water thereby modifying its effect in allocating water supplies.

This study examines the pricing behavior of the oldest and most numerous type of public water district in California. The consequences of this behavior

in terms of intradistrict water allocation is analyzed. Pricing methods and resulting patterns of water allocation are evaluated, and in conclusion, a number of pricing changes are suggested which are believed consistent with more efficient water utilization by California irrigation districts.

The term "aridity" connotes a relative lack of water in the physical sense. In California, as in far less arid parts of the United States, water increasingly is being acknowledged as scarce also in the economic sense, reflecting an expansion of activities using water. Although often associated with an increase in population, this relationship is not universal--especially if irrigation constitutes a major water use.

Water development and use requires a regulation of the natural water cycle. In arid areas whose water law makes possible the conveyance and application of surface water to nonriparian land, these regulatory activities frequently take the form of impounding structures on river systems and long conveyance systems. The high cost of these structures has led to an active role on the part of different types of public agencies in financing and managing water development undertakings.

Efforts to understand the processes of water development, administration, and use have accompanied recognition of the economic scarcity of water. This research effort may be attributed to two distinct objectives. One is to facilitate the prediction of relevant magnitudes such as costs, rates of consumptive use, etc., so that present planning may encompass future conditions more accurately. Most of these studies employ various types of predictive or projective models largely based upon historical observation. A majority of these have been descriptive.[1/]

1/ For example, see Lyle E. Craine, Water Requirements in the Muskingum River Basin in 1975 (Ann Arbor: University of Michigan, School of Natural Resources, 1957), 51p. (A Report to the Muskingum Watershed Conservancy District.) Publications of state water planning agencies have been largely of this type. See California Water Resources Board, Water Utilization and Requirements of California (Sacramento, 1955), vols. I and II. (California Water Resources Board Bulletin 2.)

although several also contain prescriptive overtones in purporting to predict optimal water development and use by components of the total economy.[1]

The other general category includes studies focusing on the adequacy of these processes in terms of public policy. They have emphasized the role of water institutions as an integral part of and influence upon water development, administration, and use. Two types of institutions of particular interest in this regard have received recent attention: water rights law[2] and water organization.[3]

The price of water varies with its relative degree of scarcity. However, institutions surrounding its development and use frequently have rendered the usual market context, within which the price of many commodities is established, inoperative. In many instances, the price of water is determined administratively without direct reference to a market.

Frequently organizations determining water price also carry on water development and management programs. Their pricing practices may be determined specifically to achieve certain allocation ends, or the allocation may be an incidental result of a price designed initially for other objectives. Evaluation of pricing methods and behavior thus entails many aspects of public districts, and criteria used must reflect the plural functions that price performs within this type of organization.

1/ A study currently underway is attempting to implement the following conclusion from a preliminary report: "By appropriate definition of limitational constraints for the state as a whole, for major sectors, for subsectors, or for some combination of these, meaningful approximations to economic optima under realistic conditions should be achievable." Ivan M. Lee, Optimum Water Resource Development: A Preliminary Statement of Methodology for Quantitative Analysis, Giannini Foundation Mimeographed Report No. 206 (Berkeley, July, 1958), p. 44.

2/ S. V. Ciriacy-Wantrup, "Concepts Used as Economic Criteria for a System of Water Rights," Land Economics, vol. XXXII, no. 4, November, 1956, pp. 295-312.

3/ Stephen C. Smith, "Problems in the Use of the Public District for Ground Water Management," Land Economics, vol. XXXII, no. 3, August, 1956, pp. 259-269.

In California the public water district was adopted as a means of organizing the use of water by established communities already engaged in irrigated agriculture as well as promoting new irrigation development. Their initial purpose was intradistrict in scope--to facilitate the development, conveyance, and use of water within their own boundaries. More recently, this form of organization has been visualized as an institution through which state-wide water allocation might be facilitated. Interdistrict relationships have become increasingly important as the activities of relatively isolated individual districts have become interrelated through water law and organizations achieving district association and as a direct result of their physical integration into large regional water development and conveyance projects.

Despite this functional evolution, public water districts continue to play a fundamental intradistrict role. Their internal performance must be understood in assessing the future contributions of such agencies in fulfilling state-wide and regional objectives for water development and distribution.

In the exposition of pricing behavior, the California irrigation district is considered a typical public water district. Actual pricing behavior of this type of public water district is directly influenced by its legal and other attributes which in themselves differentiate it from other types of public water districts. Despite this particular analytical focus of the study, the significance of the problem, the form of analysis followed, and the conclusions reached are applicable in large part to the other types of public water districts.

The analysis and evaluation of water allocation by public water districts cannot be approached adequately through any a priori economic framework. Interrelationships between surface and ground water, the various services produced by the district, and the interplay among administrative decisions by the district, state water law, and provisions of federal contract produces a broad spectrum of problems. Actual pricing behavior initially is observed and the motivations

behind the observed behavior analyzed. The resulting impact of district pricing practices is then traced out. Reliance is placed on economic theory to provide the link between pricing practices and the water allocation in which their use results. This allocation and the pricing procedures themselves then are evaluated in terms of efficiency and equity criteria. In conclusion, certain recommendations are proposed that are deemed appropriate in light of the analysis.

II. THE ALLOCATION OF WATER BY A PUBLIC DISTRICT

Water Allocation and Water Development

Water allocation differs both conceptually and empirically from water development. Until recently, the bulk of the literature on the economics of water has focused upon development problems. These are problems of making additional water available for use at designated points in space and time, frequently alluded to as "service areas" and "delivery periods." Economic questions have centered largely on issues of investment in such development works, the economic and financial feasibility of proposed projects, the allocation of the costs of such projects among beneficiaries, and examinations of the reimbursability of development projects. The activities of federal agencies[1/] in water development

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1/ The U. S. Corps of Army Engineers has been active in the improvement of navigation of rivers and harbors since 1824. In 1917, flood control responsibilities on the Mississippi and Sacramento rivers were added to their jurisdiction; and in 1936 authority for general flood control programs throughout the United States was added to these functions. The activities of the Bureau of Reclamation of the U. S. Department of Interior in water development stem principally from the Reclamation Act of 1902 which provided for the construction of irrigation works by the Bureau. In 1906 authority was granted to dispose of power generated by Bureau projects; and in 1911 additional legislation provided for the disposal of developed water outside the project area. The Fact Finder's Act of 1924 set forth certain basic requirements for project planning studies before authorization for construction could be granted. These have variously been amended by subsequent legislation. For general reference see: A. R. Golze, Reclamation in the United States (New York: McGraw-Hill Book Company, 1952), p. 451. Also see The President's Water Resources Policy Commission, Water-Resources Law (Washington, 1950), vol. 3, p. 777. (Report of the President's Water Resources Policy Commission); and C. B. Haver, History and Status of Federal Resource Development Activities, University of Chicago, Office of Agricultural Economics (Chicago, September 22, 1955), p. 19. (Research Paper No. 5512, Natural Resources Paper No. 4.)

have been largely responsible for this emphasis. Developmental issues likewise have dominated the early work in the economics of water in California. Through the Central Valley Project of the Bureau of Reclamation and numerous local projects, increasing quantities of water have been made available for use throughout the state. Paralleling these large engineering undertakings, the main focus of economic attention has been on the development of new supplies of water rather than upon the effectiveness of the distribution and use of supplies already available. Indeed, economic logic endorses the development of new water supplies so long as their incremental costs do not exceed their incremental value to the economy of the relevant service area. When the reverse relationship holds, however, a reallocation of water already developed may be economically preferable to the development of additional supplies. As discussed in detail below, this will depend upon the costs and institutional frictions entailed.

Recently, more attention has been devoted to problems of water allocation[1/] among individual uses and users. This reflects the increasing quantity of water supplied by service agencies to a relatively well-defined service area. Difficulties encountered in administering certain aspects of California's ground water law have been accompanied by an increasing consolidation of ground water rights and the appropriation of increased quantities of such water by relatively large concerns who provide distributive services to individual users requiring water for production or consumption purposes.[2/]

1/ If the service is considered a point in space, it may be said that the problem of development relates to the delivery of water to these areas, subject to certain timing conditions, and that the problem of allocation involves the disposition of such water among users and uses within and between these service areas.

2/ W. A. Hutchins, Ground Water Problems: Legal, p. 9. (Paper presented at the Conference on Legal Problems in Water Resources, Law School, University of California (Berkeley, May 17, 1957). Mimeographed.

[illegible]

[illegible]

[illegible]

California statutes likewise have afforded public and private distributive agencies advantages both in obtaining and allocating surface water. These agencies, which include public water districts, have tended to concentrate the holdings of surface water rights paralleling the trend in ground water. As these practices continue, the allocation of water rights held by service and distributive agencies can be expected to receive increasing attention in the future.

The Allocation Process

Water allocation can be conceived of as a set of data or as a process comprising a set of decisions that jointly determine an empirical result. Water allocation, as data, relates to a discernible and quantifiable pattern of water use in a designated area. Thus, one may speak of allocation in terms of types of water use. For example, water allocation among members of a district may be described by crop reports and water-duty[1/] data or by more aggregative categories such as domestic and agricultural uses.

Behind such data is a process comprising an allocator, an allocated resource, and individuals to whom the resource is allocated. These components are related through the "price" of water.

Allocation By and To Whom?

Since 1930 public water districts in California have served irrigation water to a larger acreage than any other type of irrigation enterprise, with the

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1/ Water duty refers to the quantity of applied irrigation water per acre, in terms of depth, used in irrigating specific crops in a particular region. It may be estimated or expressed in terms of observed use coefficients. Harry F. Blaney and Wayne D. Criddle, Determining Water Requirements in Irrigated Areas from Climotological and Irrigation Data (Washington: Government Printing Office, 1950), p. 48. (U. S. Soil Conservation Service TP-96.)

[illegible]

[illegible]

[illegible]

exception of individual farms (Table 1).[1] In terms of capital investment, the public district again has been the most significant type of water service enterprise except for the Bureau of Reclamation in the more recent years. (See Table 2.) However, in terms of average investment per acre-foot of irrigation water delivered, the public water district has been characterized by relatively modest investment.

Adoption of the public water district has been state-wide. Their regional concentration within California generally coincides with the prevalence of irrigated acreage. Figures I and II show the extent of irrigation acreage of the state in 1949 and counties of high absolute increase in irrigated acreage from 1930 to 1950. The central and southern sections of the Central Valley have experienced the largest absolute increase in irrigated acreage and in 1949 claimed the majority of irrigated acreage in the state. As indicated by Figures III and IV, these regions have the largest number of public water districts of any in the state.

Types of Public Water District.--Early in the statehood of California privately owned and operated water service organizations were not able to provide adequate means for coping with the water problems that were developing. In 1867[2] the first of many laws providing for public water districts was passed.

1/ An irrigation enterprise is a business, either private or public, that operates irrigation works to supply water for irrigation. District enterprises are public corporations established under special state laws. Included are irrigation districts and also other types of districts such as water improvement, water conservation, and reclamation which in some states are authorized in addition to irrigation districts and in other states in lieu of them. U. S. Bureau of the Census, United States Census of Agriculture: 1950 (Washington, 1952), pp. 3-4. (Vol. III, Irrigation of Agriculture, include the following: (1) single farm; (2) mutual or cooperative enterprises, unincorporated and incorporated; (3) district; (4) commercial enterprises; (5) U. S. Bureau of Reclamation; (6) U. S. Bureau of Indian Affairs; (7) state; and (8) city.

2/ This legislation provided for the reclamation district. See, State of California, California Water Code (Sacramento, 1957), Sections 5,000-53,901. (Derived from 1867-8:415:507, Political Code Sections 3,446-3,493b.)

[illegible]

TABLE 1

California Acreage Irrigated by Type of Enterprise, 1920-1950

Type of enterprise	Irrigated land			
	1950	1940	1930	1920
	thousands of acres			
Single farm	4,260	2,353	1,735	1,503
Mutual				
Unincorporated	127	109	854	1,216
Incorporated	762	789		
Commercial	296	392	312	813
District	1,821	1,779	1,599	577
U. S. Bureau of Reclamation	87	46	32	37
U. S. Bureau of Indian Affairs	3	4	3	1
State	a/	5	9	3
City	40	46	80	6
Other		1	123	3

a/ Blanks indicate no data reported.

Source: U. S. Bureau of the Census, United States Census of Agriculture: 1950, Irrigation of Agricultural Lands, The United States (Washington, 1952), vol. III, p. 3-3.

TABLE 1

Distribution of [illegible] by type of [illegible], [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 2

Capital Investment by Type of Irrigation Enterprise in California, 1920-1950

Type of enterprise	Capital investment							
	1950		1940		1930		1920	
	Total	Per acre irrigated	Total	Per acre irrigated	Total	Per acre irrigated	Total	Per acre irrigated
	millions of dollars	dollars	millions of dollars	dollars	millions of dollars	dollars	millions of dollars	dollars
Single farm	238.1	55.89	109.7	46.61	108.1	62.30	57.6	38.34
Mutual								
Unincorporated	4.5	35.82	3.2	29.49	42.7	50.01	48.9	40.22
Incorporated	62.8	82.39	55.0	69.68				
Commercial	31.4	105.90	28.4	72.34	24.7	78.96	45.0	55.31
District	133.9	73.51	111.7	62.81	105.3	65.89	34.0	58.88
U. S. Bureau of Reclamation	164.1	1,894.20	5.9	127.79	5.5	172.53	2.4	65.49
U. S. Bureau of Indian Affairs	1.2	452.78	1.0	241.69	.5	188.34	.1	79.71
State	.4	a/	.4	89.61	.9	95.99	.2	76.60
City	3.9	98.87	3.5	74.92	14.7	185.30	1.4	225.55
Other	.1		.1	112.71	2.4	19.94	5.3	1,589.76

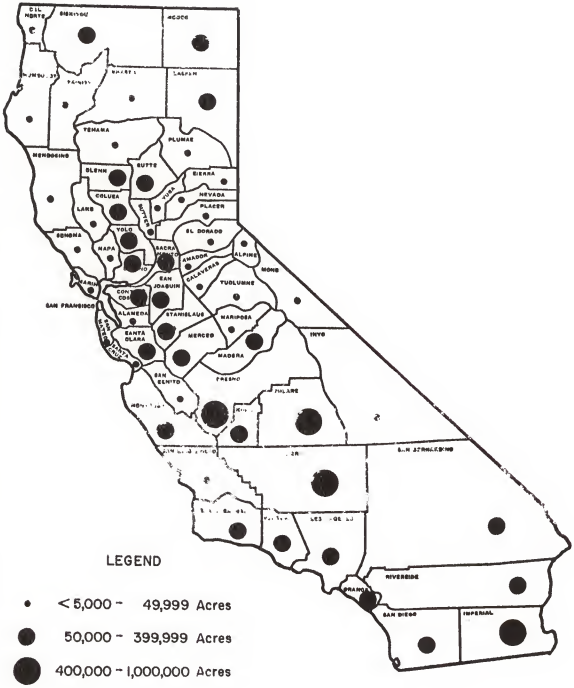
a/ Blanks indicate no data reported.

Source: U. S. Bureau of the Census, United States Census of Agriculture: 1950, Irrigation of Agricultural Lands, The United States (Washington, 1952), vol. III. p. 3-3.

[illegible]

FIGURE I

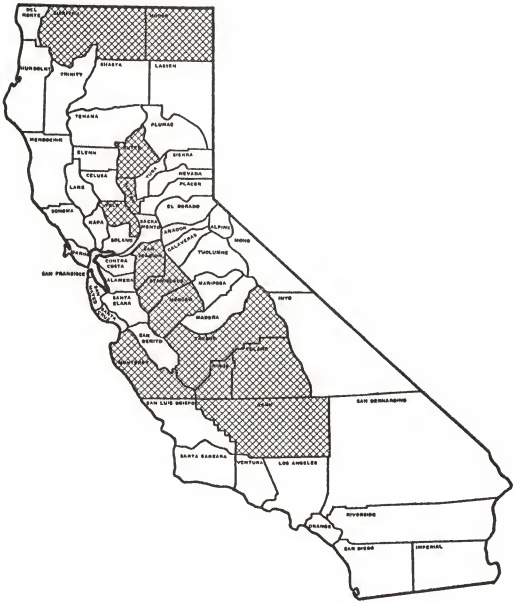
California: Acres of Irrigated Land by Counties



Source: U. S. Bureau of the Census, United States Census of Agriculture: 1950, Irrigation of Agricultural Lands, The United States (Washington, 1952), vol. III, p. 3-1.

FIGURE II

California Counties Increasing Irrigated Acreage
by More Than 50,000 Acres Between 1930 and 1950



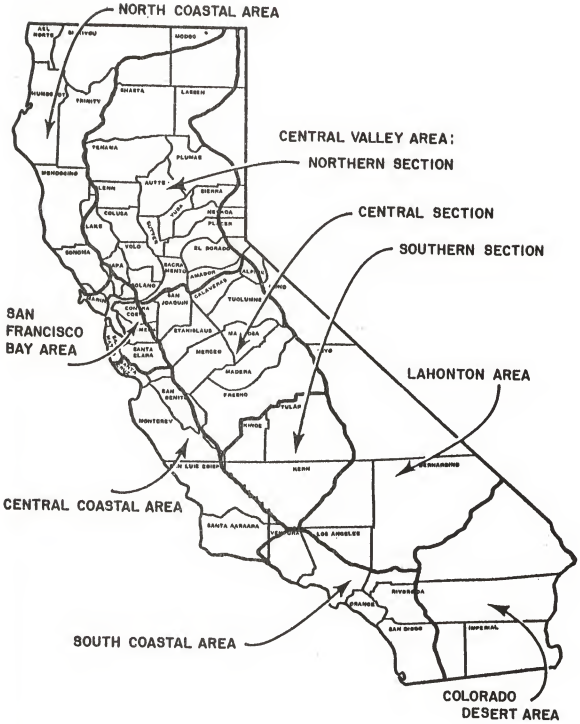
Sources:

U. S. Bureau of the Census, United States Census of Agriculture 1950, Irrigation of Agricultural Lands, The United States (Washington, 1952), vol. III, pp. 3-10 and 3-15.

U. S. Bureau of the Census, Fifteenth Census of the United States: 1930, Irrigation of Agricultural Lands (Washington, 1932), pp. 93-98.

FIGURE III

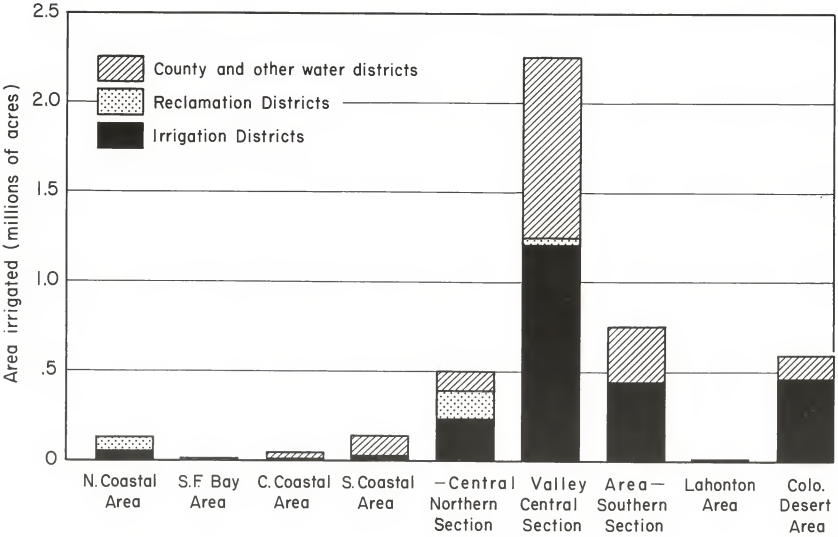
Hydrographic Areas of California



Source: California Department of Public Works, Division of Water Resources, Water Utilization and Requirements of California (Sacramento, 1955), vol. II, plate 8. (Bulletin No. 2.)

FIGURE IV

Irrigated Acreage of California Hydrologic Areas by Type of Public Water District



Source: California Department of Public Works, Division of Water Resources, Water Utilization and Requirements of California (Sacramento, 1955), vol. II, pp. 259-290. (Bulletin No. 2.)

The public district authorized by this act and nearly all subsequent public water districts have been given the power of assessment of the lands within their boundaries. Today there are in excess of 450 active public water districts in the state.

There are two methods of forming public water districts in California: general and special legislation. In the former instance, legislation specifies a particular type of district and enables the formation of any number of districts of that type in accordance with a procedure set forth in the legislation. There is provision for notice and hearing of petitions for formation which in most instances are conducted by the board of supervisors of the county within which the proposed district is located.[1] In the second method of district formation, notice and hearing are afforded by the legislative process whereby the authorizing bills are heard in committee and on the floor of the legislature.[2]

Many of the special water districts encompass an entire county or provide for a large geographic area. They have been regarded as a natural outgrowth of the local district organization movement.[3] Indeed, this appears logical as

---

1/ California Department of Public Works, Division of Water Resources, General Comparison of California Water District Acts (Sacramento, November, 1955), p. 71.

2/ The California legislature has general constitutional authority to organize taxation districts with boundaries defined in the legislative act without submitting the question to a vote of property owners within the area.

3/ J. F. McCarty, Irrigation District Movement in California, A Summary (Sacramento: State Printing Office, 1955). (Report prepared for the Assembly Interim Committee on Conservation, Planning, and Public Works.)

technical information of surface water-ground water-soil relationships have indicated larger areas as efficient water management units.[1/]

The Irrigation District--A Typical Public Water District.--The irrigation district is a public corporation organized under state laws empowering it to issue bonds and levy and collect assessments with the object of providing funds for a water supply to irrigate lands within its boundaries and for the operation and maintenance of its irrigation system. California irrigation districts are political subdivisions of the state and are organized under the jurisdiction of the county or counties in which they are located. The affairs of the district are administered by a board of directors, usually five in number, who are elected at large or by precinct. Any resident in a district who is registered may vote in district elections.

Irrigation districts in California have been formed to engage in principally new development, to acquire existing irrigation works, or to provide supplementary irrigation water supplies to areas already partially served by other sources. Basic powers accorded to irrigation districts are those necessary to furnish water in the district for any beneficial use. The district may engage in supplying irrigation water supplies; drainage activities; the leasing or purchasing of electric power; and the acquisition and operation of plants for the generation, transmission, distribution, and sale of electric power. District revenues are

---

1/ The implied chronology of these two types of acts is supported by the dates of their passage.

Period	Number of general water district acts securing passage	Number of special water district acts securing passage
1867-1900	5	0
1901-1920	8	1
1921-1940	11	4
1941-1955	5	35
Total to 1955	30	40

California Department of Public Works, Division of Water Resources, General Comparison of . . ., pp. i and ii.

obtained through assessments against unimproved property and direct charges for district services. These methods may be used separately or in combination.

An irrigation district may acquire any property, including water rights, in order to carry out its purposes and may act to furnish sufficient water in the district for any beneficial use or to put to beneficial use any water under its control. The title to all property acquired by an irrigation district is held in trust for its uses and purposes.

The owner of land within an irrigation district has the right to a share of the district's water supply for a particular year in proportion to the ratio which the last assessment against his land bears to the total district assessment.[1/]

The conventional method for enforcing the payment of delinquent assessments is by tax sale of delinquent property, although civil suit by the district is also authorized.[2/] In addition, the right to refuse delivery of water to lands for which assessments are delinquent is accorded by the state statutes. Both the general taxation statutes and district regulations make provision for the imposition of interest and penalties against delinquent lands.

Irrigation districts are exempted from payment of federal income taxes. Interest on their bonds is also exempted from such tax.[3/]

Supervisory bodies for the activities of California irrigation districts have been primarily concerned with bond issuance. In 1911, the California Bond Certification Commission was established and charged with the responsibility of approving proposed bond issues after they had been voted by the issuing irrigation

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1/ State of California, California Water Code, Section 22,250.

2/ Ibid., Section 26,018.

3/ California, State Board of Equalization, Revenue Laws of California, 1957 (Sacramento, 1957), pp. 871-872.

district.[1] In 1931, this Commission was replaced by the California Districts Securities Commission,[2] which has remained the principal agency with supervisory jurisdiction over the financial activities of California irrigation districts.

The supervisory functions of the Districts Securities Commission include the following:[3]

1. To investigate and report upon the feasibility of proposed works and the economic soundness of projects for which districts or other agency bonds are to be issued and to recommend modification of projects if deemed proper.

2. To investigate and, if approved, report bonds issued by such districts or agencies to the State Controller for certification as legal investments for funds of banks, insurance companies, and trust companies; and trust funds, and any funds for which the bonds of states, counties, or other political subdivisions are legal investments.

3. To investigate and pass upon all contracts for lease or sale of surplus water by irrigation districts.

4. To examine books and affairs of irrigation and certain other districts and agencies maintaining records of the physical and financial conditions of such districts.

5. To examine and report upon all contracts between the United States and irrigation and certain other districts involving the cost of the acquisition of any property and/or the repayment of construction costs.

The Irrigation District in California's Water Economy.--Over the 70-odd year history, more than 150 California irrigation districts have been formed, of which over 110 currently are active. Approximately 4.5 million acres are included within the boundaries of existing irrigation districts in the state, as shown in Figure V.

1/ California Laws, Statutes, Statutes of California: 1911 (Sacramento, 1911), p. 322. (Amended in special session, 1911, p. 3.)

2/ Ibid., 1931, Chapter 36, p. 788.

3/ California Districts Securities Commission, Report Upon Activities of the California Districts Securities Commission (Sacramento, 1956), pp. 10-11.

[illegible]

[illegible]

[illegible]

FIGURE V

California Irrigation Districts Organized[a] and Dissolved[b] and Gross District Acreage, 1887-1956

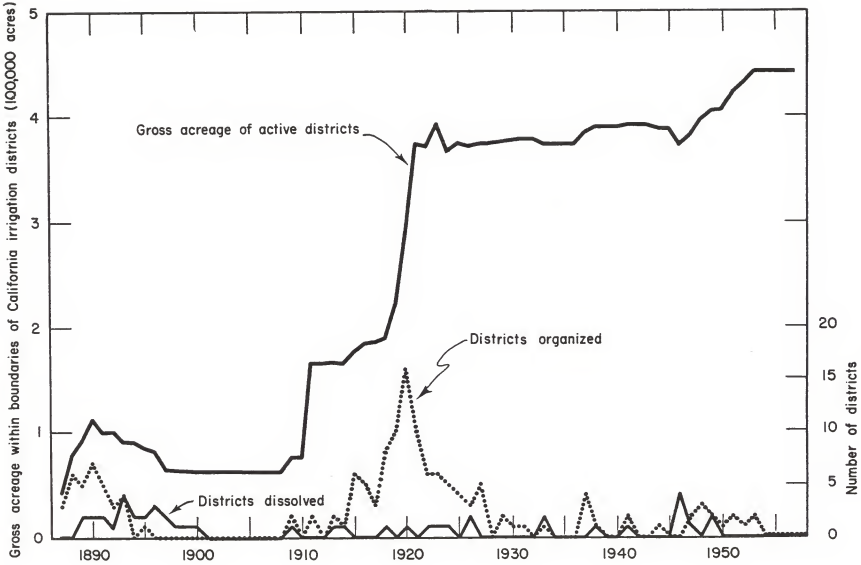

Figure V continued.

a/ Data refer to year during which election on formation was held.

b/ Data refer to year during which dissolution is issued in a court order. Frequently, districts are not active for several years prior to such an order.

Sources:

Frank Adams, Irrigation Districts in California, 1887-1915 (Sacramento: State Printing Office, 1916), pp. 114-142. (State Department of Public Works, Division of Engineering Bul. No. 2.)

Adams, Irrigation Districts in California (Sacramento: State Printing Office, 1929), p. 33. (State Department of Public Works, Division of Engineering and Irrigation Bul. No. 21.)

John F. McCarty, Irrigation District Movement in California (Sacramento: State Printing Office, 1955), pp. 23-25. (Assembly Interim Committee Report, vol. 13, no. 5, sec. 1.)

For several years prior to the passage of the Wright Act, increased activity has been noted in community endeavors to provide some basis on which an irrigated agricultural economy could be built.[1] Throughout the middle 1800's, the agricultural economy of California was primarily based upon grazing and livestock.[2] In only a few areas, close to the large centers of population in the state, were irrigated crops other than hay grown. The increase in population that the state underwent during this period gave momentum to the attempts among diverse groups within California to establish an irrigated crop economy in areas where the soil conditions and climate were favorable.

A focal point of the early agitation for the establishment of irrigated agriculture in California was the San Joaquin Valley. This area was the mid-nineteenth-century center of California wheat production. Severe drought during 1868 and 1869 threatened the dry-land agriculture of the northern portion of the Valley and emphasized the precariousness of the dry-land grain economy. Immediately after the drought, an act entitled "An Act to Encourage Irrigation" was introduced into the state Senate. It provided for the county of Stanislaus to assist in financing the Tuolumne Water Company, a private stock company. The company was to construct a dam and system of canals that would furnish water to a large portion of the county--the area largely served at present by the Modesto Irrigation District. The bill was opposed primarily because of its lack of safeguards against fraud by the water company and failed passage in 1872. Five years later, a second plan for damming and distributing the water of the Tuolumne River

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1/ Frank Adams, Irrigation Districts in California, 1887-1915 (Sacramento: State Printing Office, 1916), pp. 3 and 151. (Bulletin No. 21 of the California Department of Engineering.

2/ The value of livestock as a percentage of the value of farms in California was 42 per cent in 1859 and 5 per cent in 1954. Data from U. S. Department of Interior, Agriculture of the United States (Washington, 1864); also, U. S. Bureau of the Census, United States Census of Agriculture: 1954 (Washington, 1957), vol. 11.

was launched. This proposal called for the formation of a joint stock company comprised of land owners in the service area, however, like its predecessor, it also failed.[1]

Passage of the Wright Act in 1887 represented a major victory for the forces within the state to create the foundations on which a crop economy could be developed. The chief advantage of the irrigation-district form of organization over individual efforts to secure a supply of irrigation water lay in its financial powers. By the use of bond issues, the districts could engage in the construction of large distribution facilities which would be beyond the financial abilities of individuals. Although other advantages of the form of organization became apparent in later years, the ability to issue bonds was perhaps the most important advantage and has been attributed as the single factor most responsible for the wide adoption of the organizational form during the last parts of the 1800's and early decades of the present century.[2]

The Wright Act required only 50 signatures for a petition for district formation and enabled irrigation districts to be used for speculative purposes by small groups. Of the 52 irrigation districts formed between 1887 and 1915, 49 districts were organized under the Wright Act. Of these, only nine survived the period and were still active in 1915.[3]

The impact of the first world war and the increased western migration of population added new impetus for the establishment of an irrigated agricultural economy in the state. It was during the period from 1915 to 1930 that the irrigation district underwent its most rapid rate of growth. Seventy-five districts serving approximately 2 million acres were organized during this period. By

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1/ Sol P. Elias, Stories of Stanislaus (Modesto, California: Private Printing, 1921), p. 344.

2/ Adams, op. cit., pp. 8-10.

3/ Ibid., p. 40.

1928, these districts reported a total of 800,000 acres actually under irrigation. Twenty-two irrigation districts have been organized in California since 1929, 14 of which were formed since the end of World War II. As of 1958,[1] 107 irrigation districts were reported as active with approximately 2.5 million acres under irrigation and an assessed valuation in excess of 300 million dollars.[2]

The economic depression of the 1930's and, subsequently, the availability of water from federal projects have been important factors influencing the more recent development of California's irrigation districts. The depression's impact on district agriculture was reflected in widespread default of district bonds and other obligations. Completion of portions of the Central Valley Project during the 1940's and 1950's and the availability of contract water supplies altered the role of many districts from direct suppliers to contract intermediaries between their members and the federal government. In excess of 23 irrigation districts, contracts have been executed with the U. S. Bureau of Reclamation for supplemental water supplies and, in some instances, for distribution systems.[3]

A substantial number of districts were formed for the purpose of acquiring privately developed distribution systems which have proven adequate to meet the needs of the lands served by the acquiring district. The Central California Irrigation District formed in 1951 is an example. This district was formed to acquire water rights, canals, and other works from the San Joaquin Canal Company.[4]

1/ California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1956-1958 (Sacramento, March, 1960). (Bulletin No. 21.)

2/ Ibid., 1951-1955 (Bulletin No. 21).

3/ Of this number, 17 have completed long-term contracts with the Bureau of Reclamation and 6 have completed temporary contracts. In addition to these, 6 other districts currently are negotiating for contract with the Bureau. See U. S. Bureau of Reclamation, Water Service Repayment Review Statement, 1957 (Washington, January, 1958), map, Region 2, Water Contracting Program.

4/ This is not to imply that the Central California Irrigation District merely represents the legal transfer of ownership of the distribution facilities and water rights. The noncontinguous character of the San Joaquin Canal Company's service area has been incorporated into the boundaries of the irrigation district. This has presented problems of administration, especially with respect to the contstruction and financing of needed drainage facilities within the district.

[illegible] 1970, [illegible] a total of 30,000 acres [illegible] [illegible] [illegible] 1970. [illegible] [illegible] [illegible] 17. [illegible] [illegible] [illegible] 2.5 million [illegible] [illegible] [illegible] 20 million [illegible].[1]

The economic [illegible] of the 1970s and, [illegible] the [illegible] [illegible] [illegible]

The initial California irrigation districts, formed under the Wright and Bridgeford Acts, were almost exclusively dedicated to providing an irrigation water supply to district members. Since these original pieces of legislation, California districts have increased the scope of their activities. In 1919,[1] the generation and sale of electricity was added to the legal functions of irrigation districts, and increasingly they have been providing supplies of domestic water.

Many of the districts had installations that could well serve to provide generation sites for electricity; and as the irrigation district does not fall under the jurisdiction of the Public Utility Commission of the state, they were afforded a latitutde in pricing and other financial operations that were not available to those organizations under Commission jurisdiction. At present, five California irrigation districts are engaged in the generation and sale of power.[2] Several of these districts retail their power; and at least one, the Modesto Irrigation District, retails district power in areas outside the boundaries of the district. One district, the Imperial Irrigation District, recently has installed several steam electrical generation plants to expand its electricity output.[3]

The Resource Allocated

Irrigation districts provide a number of services, two categories of which are important to district members.

First are those products or services the individual receives with no opportunity for choice once a district activity is initiated or a certain structure completed. Products such as flood protection resulting from land treatment

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1/ California Laws, Statutes, op. cit., 1919, p. 778.

2/ California Department of Water Resources, Division of Resources Planning, op. cit., 1951-1955 (Bulletin No. 21), pp. 9-10.

3/ Imperial Irrigation District, Annual Report (El Centro, California, 1956), p. 80.

[illegible]

[illegible]

[illegible]

measures or structures are in this category. A stabilized ground water table, or a reduction in the rate of decline of a ground water table by virtue of the application of district-provided surface water, is a similar type of service. In both instances, an initial district decision creates a flow of services,[1] the quantitative extent or incidence of which cannot readily be altered by subsequent decisions of individual recipients. Although similar limitations also may extend to the district itself,[2] the district does have means, not available to individual members, that may be used to alter the rate of flow of such services.

The second category of service the members of a district may receive includes goods and services, the quantity of which the recipient may in some way regulate.[3] Products such as water supply for irrigation or domestic use and electricity are typically of this category.

The type of service provided is reflected in the criteria used for district boundary determination. Districts in which a locationally fixed area of benefit is established frequently use a boundary criterion of area benefited. Those irrigation districts that provide other services in addition to a supply of irrigation water often use internal districts. In California the most prevalent of these are the improvement and drainage districts, the perimeters of which coincide with the area receiving the locationally fixed services.

1/ This in no way implies that the extent or incidence of this flow is precisely determined before the decision that creates it is made. This may be the case with flood prevention levies or drainage works. On the other hand, the rate of ground water table recovery associated with surface water application is frequently unknown at the time district decisions are made to secure supplemental surface water supplies for recharge purposes.

2/ Frequently, the extent of the service flow may be altered by subsequent district decisions as with changes in the operation schedule of district drainage wells, but the area benefited remains essentially the same.

3/ A complete regulation may not always be exercised by the individual. Frequently, for example, water delivery methods delineate certain periods of time during which irrigators may decide upon how much water they will accept from the district, subject to some maximum amount. District water supply, however, does represent a service such that individual regulation of timing and quantity may be exercised if only within restricted ranges of choice alternatives.

[illegible]

Frequently there are interrelationships among these types of service. For example, surface water deliveries influence general ground water conditions for the district at large. Similarly, the rates at which district-generated electricity is sold may affect directly locationally fixed drainage conditions. This study is primarily concerned with water deliveries the quantity of which individual members voluntarily may control.

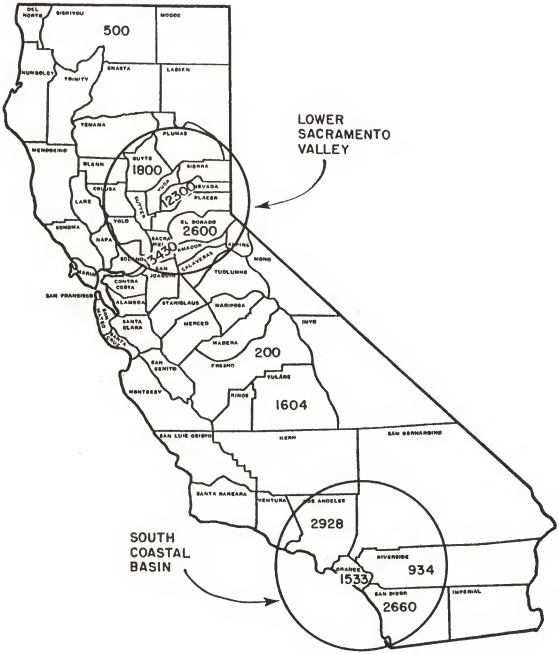
Although the main focus is on irrigation water, domestic water deliveries also are considered. Such deliveries are especially prevalent in the south coastal basin and lower Sacramento Valley (Figure VI).

Several districts in these areas assumed the ownership of organizations which provided domestic service prior to district formation. The Tranquility Irrigation District exemplifies such a situation and has continued to supply the town of Tranquility with domestic water since it took over the ownerhsip of the San Joaquin Valley Farm Lands Company in the year of its formation--1917. Other districts, and especially those in the lower Sacramento River Valley, assumed responsibility for domestic water supply as a result of a transition from agricultural to urban land use. In several districts the entire water supply has been devoted to domestic use. The Carmichael, Fair Oaks, and Citrus Heights irrigation districts are examples of such districts. Table 3 indicates the relationship between irrigation and domestic deliveries experienced by these districts from 1930 to 1955.

Although it may be argued that this trend toward domestic service will increase with future urbanization, public health requirements involve high conversion costs. If a district uses a portion of its water supply for domestic purposes either the entire water supply must be treated or a separate domestic distribution system constructed.

FIGURE VI

Number of Domestic Servicings by California Irrigation Districts[a]



a/ These data were collected between 1950 and 1954.

Source: California Department of Public Works, Division of Water Resources, Water Utilization and Requirements of California (Sacramento, 1955), vol. II, pp. 259-290. (Bulletin No. 2.)

TABLE 3

Domestic Water Delivery and Area Irrigated in Three Irrigation Districts in the Lower Sacramento Valley

District	Irrigated acreage as a percentage of gross area				Domestic water deliveries as a percentage of total district delivery			
	1930	1940	1950	1955	1930	1940	1950	1955
Carmichael	63	0	0	0	0	100	100	100
Fair Oaks	82	56	0	0	18	30	41	69a/
Citrus Heights	84	53	37b/	36	0	20	70	69

a/ Calculated from 1954 data.

b/ Calculated from 1951 data.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931). (Bulletin No. 21-B.)

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1940 (Sacramento, 1941). (Bulletin No. 21-L.)

California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1951-1955 (Sacramento, January, 1958). (Bulletin No. 21.)

TABLE 1

Comparison between Salaries and Other Employees in Three Industries Studied in the Lower Connecticut Valley

Industry	Percentage increase in average salaries, 1940 to 1950			Percentage increase in average salaries, 1950 to 1955			Percentage increase in average salaries, 1940 to 1955		
	Salaries	Other employees	Total employees	Salaries	Other employees	Total employees	Salaries	Other employees	Total employees
Manufacturing	63	0	0	0	0	0	100	100	100
Gas Utility	32	38	0	0	18	0	32	18	18[2]
Trade Industry	38	45	38[1]	20	1	20	70	46	60

1/ Data lacking for 1940 Census.

2/ Calculated from 1950 data.

Sources:

Data from Statistics of Manufacturers of Hartford County, Department of Labor Statistics, Hartford, Connecticut, 1940 to 1955 inclusive, Department of Labor, Hartford, Connecticut, 1941 to 1956.

Data from Statistics of Public Utility, Industry in Hartford County, Department of Labor Statistics, Hartford, Connecticut, 1940 to 1955 inclusive, Department of Labor, Hartford, Connecticut, 1941 to 1956.

Data from Statistics of Trade Industry, Industry in Hartford County, Department of Labor Statistics, Hartford, Connecticut, 1940 to 1955 inclusive, Department of Labor, Hartford, Connecticut, 1941 to 1956.

Water--A Heterogeneous Resource.--The growing literature on the physical problems of water development and the economic issues associated with its use frequently have considered water as a single, homogeneous factor of production.[1]

The fields of hydrology and agronomy long have recognized the range of chemical and bacteriological variation to which irrigation water is subject.[2] Irrigationists have been explicitly aware of the importance of the timing and frequency of water application to the quantity and quality of product produced from irrigated cultivation.[3] Members of irrigation districts are concerned further with the location of their district's water supply in relation to the land on which it is to be applied. If transportation and/or pumping costs must be undergone by him before this water can be applied, net returns are reduced in some proportion to the magnitude of these costs. Thus, irrigation water as an economic factor of production may differ with respect to its quality, timing, and placement.

To some extent these elements of difference are mitigated by the district organization. Quality differences in various sources of a district's supply are reduced as these waters are commingled in the distribution system. Differences in the placement of individual parcels of land with respect to the district's distribution system are overcome largely by the formation of improvement

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1/ This allusion frequently is incorporated explicitly into diagrammatic exposition. For example, see John G. Timmons, "Theoretical Considerations of Water Allocation Among Competing Uses and Users," Journal of Farm Economics, vol. XXXVIII, no. 5, December, 1956, pp. 1244-1258.

2/ Committee on Quality Tolerance, "Progress Report on Committee on Quality Tolerance of Water for Industrial Uses," Journal of New England Water Works Association, vol. 54.

3/ See Christoph Beringer, "Toward an Understanding of the Production Function for Water." (Unpublished manuscript.) Also see J. R. Stockton and L. D. Doneen, "Effects of Irrigation on the Growth and Yield of Cotton," California Agriculture, vol. 9, no. 7, July, 1955, pp. 8-10.

districts or community lateral associations.[1] These organizations supplement the distribution facilities of the irrigation district. They are formed within the boundaries of an irrigation district and are managed by the board of directors of the parent irrigation district. Improvement district members pay costs associated with the operation of the improvement district as well as costs associated with the operation of the irrigation district within which they are situated. Their average total costs for district services will exceed those costs paid by members of the same irrigation district who are not within the boundaries of the particular improvement district. Similar regional differentiation of cost may exist in the absence of improvement districts.[2]

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1/ The improvement district has been a widely adopted method of extending distribution facilities owned by the parent irrigation district where such extensions serve a clearly demarked group of irrigators. Such construction is financed by assessment on the unimproved property within the improvement district boundaries. See State of California, California Water Code, Sections 23667-23672. Community lateral associations were authorized in 1957 to contract with irrigation districts and function in a similar manner to the improvement districts. See California Department of Water Resources, op. cit., 1957, Chapter 876. Only one California irrigation district employs the community laterals--the Central California Irrigation District. See "Landowners Petition and Ditch Contract with Central California Irrigation District" (contract form secured from the files of the Central California Irrigation District). It is believed that such community laterals will be eligible for financial assistance from the federal government as a local water development endeavor. The improvement districts are ineligible for such assistance by virtue of compulsory membership in the district with two-thirds vote of potential members and consent of the board of directors of the parent irrigation district. See State of California, California Water Code, Sections 23665-23674.

2/ For example, the Delano Earlimart Irrigation District distinguished between five areas, the servicing of which requires lift pumping from the Friant-Kern Canal from which the district receives its supply of irrigation water. The following acre-foot charges are in effect for the 1958 irrigation season:

Lift number	Charges
1	$2.50
2	$2.90
3	$3.35
4	$3.95
5	$4.50

Delano Earlimart Irrigation District, Rules and Regulations for Delivering of Water, Water Charges, and the Payment Thereof, Section 3, February 1, 1958. (Mimeographed circular.)

Although differences in quality and placement do not raise major conceptual problems for the process of intradistrict water allocation, it will be shown that they are of considerable consequence for interdistrict allocation. One characteristic, however, is directly related to allocation within a given district--the timing of district water availability to individual members. In general, the less restrictive the timing requirements on the use of district water supply, the more perfectly it becomes substitutable with water from other sources available to district members.[1/]

District Water Price--A Payment Complex

Several types of irrigation district charges upon its membership have been mentioned. Which of these can be called the "price" for district water or what combination of them may be so considered? If viewed in terms of direct receipts per unit of sale, the water toll appears relevant. On the other hand, price is more usually considered as the sum of money or other goods that must be exchanged for a unit of product. This is a more comprehensive concept and is consistent with this study's emphasis on water allocation. Total monetary expenditures by an individual for a supply of water from a California irrigation district therefore are defined as the water "price."

Why a Complex?--The payment of district assessments and other charges may legally be made a prerequisite to an individual member receiving water deliveries from his district. This collection of charges is referred to as the payment

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1/ This does not imply that an immediate substitution of sources will result from the liberalization of timing requirements. Indeed, the demand function for water from a given source for an irrigated farm tends to be discontinuous with highly inelastic segments, the length of which are determined by the production possibilities, the anticipated prices to be received, and the availability of water from alternative sources. A reduction of timing restriction on district water, however, will tend to reduce the extent to which the price ratio of district water to water from other sources would have to change to induce the use of greater quantities of district water--or increase the extent to which this ratio would have to fall to reduce the quantity of district water used.

complex. It must be specified both in absolute and relative terms: the magnitude may be changed and so too may the proportion that its components bear to each other. Both types of change are important in their influence upon the allocation of district water.

Components of the Payment Complex.--Two forms of payment employed by districts are the water toll (a unit charge) and an assessment. The actual components of the payment complex depends upon the activities of the district and the manner in which its financial transactions are undertaken. As California irrigation districts are authorized to use a variety of funds and as no uniform system of accounting has been adopted, their financial organization demonstrates considerable variety.

The California Districts Securities Commission has established a fairly uniform system of accounts for presenting annual financial transactions. This includes five separate funds: a general fund for maintenance and operation, bond interest and retirement fund, a time warrant interest and redemption fund, construction fund, and an improvement and subdistrict fund.

Within this context, it is possible to identify the components of the total payment made by members to their district. The majority of California irrigation districts receive income from both water sales and assessments. Thus, the typical district member pays his district an annual assessment and water tolls. Some districts charge only quantity unit tolls, others use tolls in combination with fixed charges, sometimes referred to as stand-by fees, which the irrigator must pay if he is to receive a supply of water in a given year.

District assessments are levied on an unimproved property value base. The total rate of levy is the aggregate of component rates attributed to different funds. For example, in 1956 the Beaumont Irrigation District charged a rate of levy of $2.50 per $100 valuation for the general fund; $2.00 for the bond interest

and redemption fund; and $.50 for the construction fund--the total rate of levy of $5.00 being made upon the same property valuation base.[1]

Receipts for the improvement and subdistrict fund, however, may be raised by charges for the use of water or for any other service furnished by means of the works of the improvement district as well as assessments.[2]

Since 1890 the statutes of California have held that the assessments levied by California irrigation districts be made on a property base value, excluding improvements but including city and town lots.[3] It is further required that this property base be valued at its full cash value.[4] In practice, districts employ a variety of systems of land valuation.

The amount of assessment with which an individual irrigator is charged will depend upon his acreage, its valuation by the district, and the rate of levy that the district imposes on this property value base. This total charge must be paid unless the area considered is specifically excluded from assessments without regard to the water supply provided the irrigator.

An important characteristic of the payment complex, and one that differentiates it sharply from the usual price concept, is that the components for a particular year are not determined by market forces. Both the district assessment and the water toll are administratively established by the board of directors of each irrigation district. Certain guides to this process are established in

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1/ California, State Controller's Office, Annual Report of Financial Transactions Concerning Irrigation Districts of California: 1956 (Sacramento, 1956), p. 20.

2/ The board of directors of the irrigation district within which an improvement district is located may provide for the maintenance and operation of the works of an improvement district from the funds of the irrigation district in lieu of levying further improvement district assessments. State of California, California Water Code, Section 23955.

3/ Ibid., Section 25500.

4/ Ibid., Section 25503.

the state statutes and financing arrangements of each district--especially with respect to the fixed contractual outlays; but these guides are not necessarily related to the water supply and demand characteristics of the district. This gives rise to a substantial variety of "prices" actually charged by irrigation districts.

III. THE PRICING BEHAVIOR OF CALIFORNIA IRRIGATION DISTRICTS

Pricing and Irrigation District Legislation

Analysis of the pricing procedures of California irrigation districts is handicapped by the absence of data prior to the year 1930. Systematic records compiled from annual reports of the California Districts Securities Commission have been maintained since then. Prior to 1930, certain aspects of irrigation district legislation are indicative of the pricing practices used. This body of legislation is briefly reviewed before analyzing more recent district pricing practices.

California irrigation district law primarily has been concerned with the assessment component of the payment complex. In particular, the assessment base and the area within a district subject to assessment have been the subject of successive legislation. The water toll has been provided for since the original Wright Act, and its use has been left largely to the discretion of a district's board of directors.

The Wright Act (1887) is generally worded with respect to the assessment base, stating that the bonds issued by California irrigation districts and their interest shall be paid by revenue derived from an annual assessment upon the real property of the district and specifying all real property as being liable for such assessment.1/

1/ California Laws, Statutes, op. cit., 1887, Chapter 39, Section 17.

[illegible]

[illegible]

[illegible]

Legislation passed in 1891 required districts to list separately land and the improvements thereon in their assessment book[1] but did not clarify the general wording of the Wright Act in spelling out how these two accounting entries were to be used in determining a value base for district assessment. Such clarification is embodied in legislation passed in 1907[2] which specifically states that improvement on any lands or town lots within an irrigation district shall be exempt from district assessments. The term "improvement" is defined to include trees, all growing crops, and all buildings and structures. A rider permitted districts organized prior to the passage of this act, which traditionally valued town lots inclusive of improvements, to continue this practice. This temporary advantage to agricultural interests was terminated in 1917[3] when new legislation specifically stated that land exclusive of all improvements would constitute the basis for property valuation.

This uniform definition was ended in 1927 by legislation[4] permitting the formation of improvement districts internal to irrigation districts and authorizing them to assess members. Such assessment explicitly is required to be in accordance to the benefit that will accrue to each of the tracts of land within the improvement district by virtue of the expenditure of funds for improvement district purposes. These provisions have continued to the present.

For two years during the depression, 1937-1939, temporary legislation permitted the valuation of land for assessment purposes according to ability-to-pay criteria. It stated:

1/ Ibid., 1891, pp. 244-246.

2/ Ibid., 1907, p. 569.

3/ Ibid., 1917, p. 734.

4/ Ibid., 1927, pp. 1414-1418.

> . . . as many of the districts were organized during a period of rapid expansion and inflated values, they have become increasingly unable to meet the obligations of their bonded indebtedness and that the mounting defaults in such districts and the consequent pyramiding of assessments constituted almost a situation of property confiscation. And that the increasing delinquencies and inability to sell and foreclose by the district has caused a condition of chaos.1/

This legislation represents an attempt to circumvent delay in the administration of district refinancing procedures during these three years. The Districts Securities Act of 1931 provided for the Districts Securities Commission to administer the affairs of districts defaulting on bond principal and interest payments. Under the Act, the Commission was empowered to assess members of such districts according to their ability to pay. The 1937 legislation merely removed the conflict between these assessment procedures and those existing in the district legislation requiring a unique rate of levy and the full cash valuation on assessed land. This temporary legislation was terminated in 1939 2/ with the re-establishment of unimproved land as the base for assessment valuations. The value to be placed upon such land has consistently been stated to be the full cash value of such land by subsequent legislation.

With respect to the area subject to district assessment, the Wright Act was largely permissive. In practice, the entire gross acreage of early California irrigation districts was assessed. It was not until 1891 that an act specified what areas in a district were to be assessed. Territories within the district susceptible to irrigation by the same system of works applicable to other lands within the district were subject to assessment.3/ In 1913 this definition was broadened, giving specific recognition to benefits from surface and ground water

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1/ Ibid., 1937, pp. 491-493.

2/ Ibid., 1939, pp. 1038-1039.

3/ Ibid., 1891, pp. 142-147

relationships resulting from the functioning of an irrigation district. The act touched upon exclusion petitions from areas within district boundaries. Stating that:

> . . . lands petitioning for exclusion from a district may be granted their request if these lands cannot be irrigated from, or are not susceptible to, or would not, by reason of being permanently devoted to uses other than agricultural, be directly benefited by district irrigation.1/

The legislation specifically included any benefits resulting from district activity realized by members irrigating with privately pumped ground water; however, it established conditions on the liability to assessment of such lands. Those areas which have continued to irrigate from a privately pumped water supply since before district formation are susceptible only to assessment for the payment of interest and principal due on bonds of the district.

The omission of specific boundary inclusion and exclusion in the Wright Act is understandable as its primary objective was to establish the districts as local institutions with the power to issue bonds. A concerted effort was made to keep the bill as simple as possible with other issues related to the organization and functions of irrigation districts being introduced through either amendatory or supplementary acts. Indeed, this is the form in which the first provisions for boundary changes were introduced.

The legislation of the 1890's and early 1900's dealing with district boundary change provide for the establishment and maintenance of district integrity. Specific legislation requires benefiting areas to be included and areas not benefited by irrigation from the same irrigation system to be excluded. The major irrigation district act of the 1890's--the Bridgeford Act--however, did acknowledge that inclusion and exclusion were issues that would change with time and could not be answered

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1/ Ibid., 1913, p. 782.

by specific legislation. This Act merely stated that boundary alterations must not impair the operations of the district.

The 1913 legislation cited above recognized certain ground water benefits that were complementary to the surface water irrigation activities of the district and the exclusion regulations were modified accordingly.

During the depression years, financial problems of California irrigation districts are reflected in specific legislation on boundary changes with various acts attempting to set forth the financial commitments on such areas. In 1943 the numerous attempts to legislate a specific set of conditions for the inclusion of new lands to an existing irrigation district were replaced by general legislation giving the board of directors power to stipulate specific conditions for inclusion.1/

Subsequent to 1930, district data are available that permit more specific analysis of the pricing practices they have employed. These are considered below.

The Assessment Practices of California Irrigation Districts

There are three determinants of the assessment charged a member by his district: (1) the size of the land holding, (2) its valuation, and (3) the total rate of levy employed.2/ Each of these must be analyzed for an understanding of a district's assessment behavior. The area assessed is expressed as a percentage of the gross acreage of each district. Assessed valuation initially is expressed by the average valuation per acre subject to assessment by each district. The total rate of district levy may be directly observed and is comparable between districts.

1/ State of California, California Water Code, Section 26902, p. 442.

2/ The California Water Code provides general instructions for the determination of the assessed valuation of land subject to district assessment (Section 25503) and the total rate of levy (Section 25801). The determination of the area of an irrigation district to be subject to assessment is generally established by district referendum and modified by the district board of directors.

The behavior of California irrigation districts in employing the district assessment component of the payment complex has demonstrated considerable change--both from the standpoint of state-wide averages over time and between groups of districts.

Acres Assessed.--The percentage of gross district acreage subject to assessment has remained relatively constant from 1930 to the present with from 72 to 80 per cent being so subject. Changes in the total assessed acreage reflect fairly accurately the extent of the irrigation district as a form of organization since the mid-1940's. Almost all new areas included or old areas excluded from active irrigation districts since this year have comprised acreages subject to assessment. This is not surprising as an anticipated benefit from the water supply functions of the district to the area petitioning for inclusion is presumed the logic behind such action. Likewise, an avoidance of otherwise unavoidable district costs--the district assessment--is presumed the objective in petitions for exclusion.

Prior to 1945, lands held by the districts under tax deed materially reduced the area legally susceptible to district assessment. From 1937 to 1945, increases in the assessed acreage of districts were largely attributable to the redemption of formerly tax-held lands within the boundaries of individual districts.[1]

1/ The percentage of gross average of all California irrigation districts held under tax deed from 1930 to 1950 are as follows:

1930 - 2.1	1940 - no data available
1931 - 4.8	1941 - 7.1
1932 - 5.6	1942 - 5.1
1933 - 6.0	1943 - 4.6
1934 - 6.6	1944 - 3.4
1935 - 10.1	1945 - 3.0
1936 - 10.0	1946 - 1.8
1937 - 10.2	1947 - 1.5
1938 - 9.7	1948 - 1.3
1939 - 9.9	1950 - 1.1

California Department of Public Works, Division of Water Resources, op. cit., 1930 (Bulletin No. 21-B); 1931 (Bulletin No. 21-C); 1932 (Bulletin No. 21-D); 1933 (Bulletin No. 21-E); 1934 (Bulletin No. 21-F); 1935 (Bulletin No. 21-G); 1936 (Bulletin No. 21-H); 1937 (Bulletin No. 21-I); 1938 (Bulletin No. 21-J); 1939 (Bulletin No. 21-K); 1940 (Bulletin No. 21-L); 1941 (Bulletin No. 21-M); 1942 (Bulletin No. 21-N); 1943 (Bulletin No. 21-O); 1944-1950 (Bulletin No. 21-P).

[illegible]

[illegible]

[illegible]

Data on the actual assessed acreage of districts have not been maintained prior to 1940. A trend of acres assessed for the period 1930-1940 has been drawn freehand in Figure No. VII on the assumption that during the earlier years of this period a higher percentage of the gross assessable acreage of irrigation districts were assessed than during the later years of the period.[1/]

If this trend is representative, the high percentage of the gross acreage which was assessed during the early 1930's fell substantially during the middle and late 1930's and early 1940's. It increased during the late 1940's and 1950's, however, not to the level of the early 1930's.

Two factors are reflected in these aggregate figures. First is the high percentage of the gross acres held in tax deed by the district from 1935 to 1943. The second factor, indicated by a comparison of the end dates of the interval considered, is the increased exemption of areas from district assessment under relatively low levels of tax-held lands. This observation is in keeping with the decreasing percentage of total receipts to California irrigation districts represented by assessment receipts demonstrated in Table 4.

It is interesting to note that although the percentage of gross acreage of California irrigation districts assessed has increased only slightly over the past 16 years, the tendency among individual districts--over the 1940-1956 period--has been a larger increase in the percentage of gross acreage subject to district assessment. In 1940 individual districts assessed 82 per cent of their gross acreage on the average. This percentage increased to 92 in 1956.[2/] These data

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1/ For the year 1927-28, 96.2 per cent of the aggregate gross acres of California irrigation districts were assessed. By 1940, the next year for which are available, this percentage had dropped to 78 per cent. Data for 1927-28 were taken from Adams, Irrigation Districts in California, 1929 (Sacramento: State Printing Office, 1929), Table 1, pp. 389-390. (California Department of Public Works Bulletin No. 21.) Data for 1940 were taken from ibid., 1939 (Bulletin No. 21-K).

1/ Computed from data in California Department of Public Works, Division of Water Resources, op. cit., 1941 (Bulletin No. 21-L) and California Department of Water Resources Planning, Report on Irrigation and Water Storage Districts . . .

[illegible]

FIGURE VII

Gross Acreage and Acres Assessed by All California Irrigation Districts, 1930-1956a/

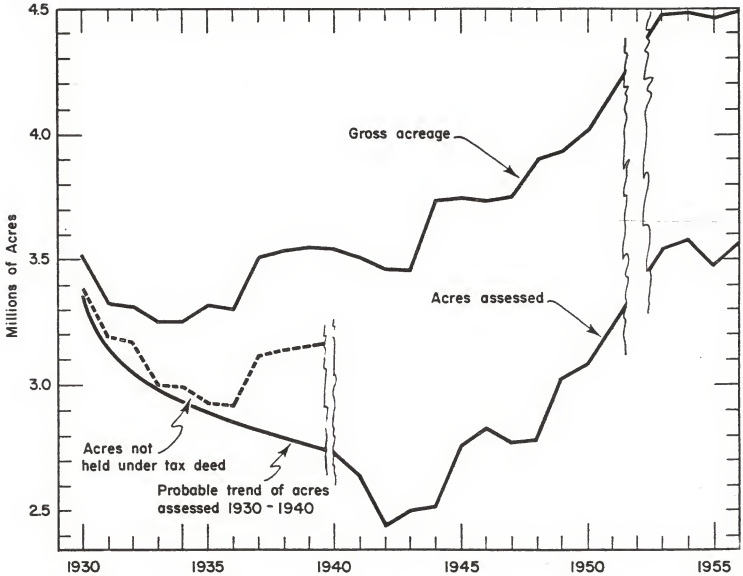

Figure VII continued.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931). (Bulletin No. 21-B.)

Ibid., 1931 (Bulletin No. 21-C).

Ibid., 1932 (Bulletin No. 21-D).

Ibid., 1933 (Bulletin No. 21-E).

Ibid., 1934 (Bulletin No. 21-F).

Ibid., 1935 (Bulletin No. 21-G).

Ibid., 1936 (Bulletin No. 21-H).

Ibid., 1937 (Bulletin No. 21-I).

Ibid., 1938 (Bulletin No. 21-J).

Ibid., 1939 (Bulletin No. 21-K).

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1941 (Bulletin No. 21-M).

Ibid., 1942 (Bulletin No. 21-N).

Ibid., 1943 (Bulletin No. 21-O).

Ibid., 1944-1950 (Bulletin No. 21-P).

Robert C. Kirkwood, State Controller, Annual Report of Financial Transactions Concerning Irrigation Districts of California, Calendar Year 1953 (Sacramento: State Printing Office, 1954).

Ibid., 1954.

Ibid., 1955.

Ibid., 1956.

Figure 7.1 continued.

Sources:

Wallison de Lucena Lopes de Paula, Marta Moreira, Divisão de Water Resources, Secretaria de Infraestrutura e Hídricos do Ceará, the Year 2020 (Fortaleza, 1997), [illegible].

Table 1. 1916 (Data run No. 7-01).

Table 2. 1918 (Data run No. 22-01).

Table 3. 1920 (Data run No. [illegible]).

Table 4. 1924 (Data run No. [illegible]).

Table 5. 1925 (Data run No. [illegible]).

Table 6. 1926 (Data run No. [illegible]).

Table 7. 1927 (Data run No. [illegible]).

Table 8. 1928 (Data run No. 21-1).

Table 9. 1929 (Data run No. 21-1).

Table 10. 1930 (Data run No. 21-1).

Table 11. 1931 (Data run No. 21-1).

Table 12. 1932 (Data run No. 21-1).

Table 13. 1933 (Data run No. 21-1).

Table 14. 1934 (Data run No. 21-1).

Table 15. 1935 (Data run No. 21-1).

Table 16. 1936 (Data run No. 21-1).

Table 17. 1937-1940 (Data run No. [illegible]).

Robert C. Kirkwood, Stella Cavalcanti, Jorge Machado, "Water Budget of Jaguaribe Basin: Simulation Exercises Using Historical Data," in [illegible], [illegible] (Fortaleza: [illegible], 1997).

Table 1. 1966.

Table 2. 1967.

Table 3. 1968.

TABLE 4

Receipts of All California Irrigation Districts and Its Components, 1940-1956

Year	Receipts from district assessments[a]		Receipts from water sales		Total district receipts[b]
	hundred thousands of dollars	per cent of total	hundred thousands of dollars	per cent of total	hundred thousands of dollars
1940	43.0	52	29.2	35	82.3
1941	--[c]	--	--	--	--
1942	50.8	100	--	--	50.8
1943	51.1	57	38.9	43	90.0
1944	51.6	55	42.6	45	94.2
1945	51.0	54	43.0	46	94.0
1946	57.8	51	56.3	49	114.1
1947	58.5	47	66.6	53	125.1
1948	58.8	43	78.3	57	137.1
1949	65.2	44	82.3	56	146.6
1950	70.8	46	83.8	54	155.6
1951	79.0	46	93.0	54	172.1
1952	87.0	46	104.0	54	191.0
1953	92.3	43	123.5	57	215.2
1954	104.7	45	129.7	55	234.4
1955	104.7	44	131.1	56	235.8
1956	109.5	43	141.9	57	251.4

a/ Data include penalties for payment of late assessments.

b/ Total receipts exclude returns to districts from land and electric power sales.

c/ Dashes indicate no data available for this year.

(Continued on next page.)

Table 1

Population of [illegible] and the [illegible], [illegible]

Year	Population [illegible]				Population [illegible]				[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

Table 4 continued.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year, 1940 (Sacramento, 1941) (Bulletin No. 21-L).

Ibid., 1942 (Bulletin No. 21-N).

Ibid., 1943 (Bulletin No. 21-O).

Ibid., 1944-1950 (Bulletin No. 21-P).

Robert C. Kirkwood, State Controller, Annual Report of Financial Transactions Concerning Irrigation Districts of California, Calendar Year 1951, Calendar Year 1952 (Sacramento: State Printing Office, 1954).

Ibid., 1953.

Ibid., 1954.

Ibid., 1955.

Ibid., 1956.

indicate the general tendency of larger districts to increase the percentage of gross acreage accessed at a less rapid rate than smaller districts.

The larger irrigation districts in California are located in the northern part of the Sacramento Valley or the Colorado Desert area. These districts owned substantial appropriative rights to water at the time of their formation.[1/] The actual rate of development of irrigated acreage within their boundaries has been limited primarily by the large investments necessary to provide extensions or additional units to their distribution systems. Such extensions and additions have entailed periodic issuance of bonds for construction purposes. As the acreage assessed in these larger districts approximate the areas actually receiving district water, further increases in the area assessed have been determined by the scheduling of these bond issues. A major exception is found in those large districts early established on the east side of the San Joaquin Valley that engage in the generation and sale of electricity. As is discussed below, those districts traditionally make substantial transfers from their electricity sale receipts to cover costs associated with their functioning to provide a supply of irrigation water. The result of this practice has been a relatively low cost to irrigators for water and, accordingly, a relatively early and rapid development of irrigated cultivation within their boundaries. These districts characterized by a high percentage of their gross acreage already assessed in 1930, would demonstrate a relatively slow rate of additional increase over the 1930-1955 period.

In contrast with these large districts, smaller districts in the Central Valley area frequently were limited in size by the water rights they acquired at the time of formation. This size limitation, however, entails smaller capital outlays for distribution systems, enabling the relatively rapid development of

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1/ The northern portion of the state generally is characterized by substantial unappropriated water. These large districts in the Colorado Desert area, the Imperial, and Palo Verde irrigation districts, have appropriative rights long standing for Colorado River water--the dates of filing being 1895 and 1877, respectively. See Adams, Irrigation Districts . . . 1929, pp. 327-345.

a higher percentage of their gross acreage. An additional factor explaining the rapid increase in the percentage of gross acreage assessed over the 1930-1955 period was the transition in land use in many smaller districts from agricultural to subdivision and the assumption of domestic water deliveries by the district. When such was the case,[1] the area provided with domestic service characteristically has been assessed. Although several of these districts have been entirely subdivided and have devoted their entire supply of water to domestic services, the early stages of the transition in land use entailed the subdivision of nonagricultural lands thus expanding the assessed percentage of the gross acreage of such districts.

Over the entire period covered (1930-1956) 44, or approximately 70 per cent, of the 66 districts on which the pertinent data are available demonstrate a change in the acreage subject to district assessment. (See Table 5.) Twenty-six of these decreased the acreage so subject, 19 increased this acreage, and 22 remained unchanged. More individual districts underwent changes in such acreage during the two 5-year intervals, 1930-1935 and 1935-1940, than during other intervals in the period covered. The 1945-1950 interval indicates the smallest number of districts undergoing a change in this acreage.

Data on acres assessed for the years 1930 and 1935 are approximations derived by deducting tax-held district lands from the gross acreage of such districts. The extent of district assessment default by members is emphasized by irrigation district legislation passed in 1933 which claimed widespread default

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1/ This occurred particularly within districts in the lower Sacramento Valley and the south coastal plain.

TABLE 5

Changes in Acres Assessed by California Irrigation Districts, 1930-1956

Year-interval	Districts on which data are available	Districts undergoing change	Districts increasing acres assessed	Districts decreasing acres assessed	Districts undergoing no change
1930-1956	66	44	18	26	22
1930-1935	77	41	2	39	36
1935-1940	68	39	16	23	29
1940-1945	65	27	19	8	38
1945-1950	70	19	16	3	51
1950-1955	79	26	19	7	53

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931) (Bulletin No. 21-B).

Ibid., 1935 (Bulletin No. 21-G).

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1944-1950 (Bulletin No. 21-P).

Robert C. Kirkwood, State Controller, Annual Report of Financial Transactions Concerning Irrigation Districts of California, Calendar Year 1955 (Sacramento: State Printing Office, 1956).

Ibid., 1956.

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

as reason for an emergency classification of the Statute.[1/] The decrease in acreage assessed may be attributed to two factors: (1) the actual loss of district land to the assessment rolls by tax default and (2) a reduction of the assessed acreage by districts in anticipation of such default in the event that such land be left on the assessment rolls.

Over the five years--1935-1940--the majority of districts experiencing change in the acreage assessed again decreased the acres so subject. By 1940 a large number of irrigation districts had completed refinancing plans through various programs designed to assist districts defaulting on their bonded indebtedness. The operation of about a quarter of the then active California

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1/ An act relating to the redemption of property sold to irrigation districts states:

"The legislature hereby declares it an emergency. Due to the agricultural depression which has existed for the past several years, many landowners in irrigation districts in the State have been unable to meet their annual taxes and assessments with the result that their land has been sold to the district. The heavy penalties necessary to get paid as now provided by law, and which continually increase, making it impossible for the landowner to redeem his land and thousands of landowners are now threatened with the loss of their land. If the land is not redeemed and if it is deeded to the district, it then becomes nonassessable for district purposes, and the burden becomes all the heavier on the other landowners in the district causing more delinquency and loss. The legislature hereby declares that the welfare of the State requires that the landowner in these districts not be dispossessed of his land, and that the land be redeemed so as to thenceforth bear its just proportion of taxation." California Laws, Statutes, op. cit., 1933, pp. 2191-2192.

Further legislation during this period (1935) enabled irrigation districts in default of their bonded indebtedness by more than 20 per cent to apply to come under the supervision of the California Districts Securities Commission. See California Laws, Statutes, ibid., 1935, pp. 359-361. This provision authorized the districts so subject to levy annual assessments in amounts approved by the Commission. Eighteen districts applied under this legislation for Commission supervision in 1933; and in 1941, when the terms of the statute expired, 15 of a total of 28 districts were still under supervision of the Commission. These districts were:

Banta-Barbona	James	Groville-Wyandotte
Byron-Bethany	Lindsay-Strathmore	Provident
Corcoran	Merced	Thermalito
El Camino	Montague	Tracy-Clover
Grenada	Naglee-Burk	Waterford

[illegible]

irrigation districts under supervision of the California Districts Securities Commission had a marked effect on reducing the instances of individual tax default by district members and, hence, the more moderate rate of decline in acres assessed.[1]

The increasing trend of acres assessed during the periods 1940-1945 and 1945-1950, undoubtedly affect the general economic setting of this period which was characterized by a marked expansion of California irrigated agriculture. It was also during this decade that the major impact of the transition in land use from agricultural to urban occurred. A further factor serving to stimulate the expansion of irrigated cultivation within California irrigation districts during the late 1940's was the availability of water from the Central Valley Project. Although the majority of contracts date during the 1950-1955 period, five districts secured water service contracts from the Friant-Kern Canal prior to 1950.[2]

During the latest five-year interval for which data are available (that of 1950-1955) 26 of the 76 California irrigation districts on which underwent a change in their acreage assessed. Of these districts, 19 increased the acreage within their boundaries so subject and 7 decreased the number of acres assessed for district purposes. The principal increase in acreage assessed during this

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1/ In 1933 the Emergency Farm Mortgage Act was amended to authorize the Reconstruction Finance Corporation to make loans up to $50,000,000 to various districts including irrigation districts for refunding outstanding indebtedness of such organizations. This was increased to a $125,000,000 limit in 1934. Out of a total of 28 that were operated under the California Districts Securities Commission, only 7 districts were in current default status in 1941. They were:

Baxter	Montague	Table Mountain	Williams
El Camino	Stinson	Tule	

See California Department of Public Works, Division of Water Resources, op. cit., 1941 (Bulletin 21-M), p. 23.

2/ These were the Ivanhoe, Lindmore, Lindsay-Strathmore, and Orange Cove irrigation districts. U. S. Bureau of Reclamation, op. cit., Table 7.

[illegible]

[illegible]

[illegible]

period occurred in the service area of the Friant-Kern Canal, reflecting the irrigated acreage increase made possible from the supplemental water supplies obtained from the Central Valley Project.

Assessed Valuation.--The total assessed valuation of an irrigation district is determined by two factors--the area subject to assessment and the method used for establishing an assessed valuation. The annual assessment levied is determined on the basis of a fixed rate of levy, expressed as a specified sum, payable per hundred dollars of assessed property valuation. The magnitude of the assigned property value is thus directly related to the size of the water payment he will make in any one year in the form of district assessment.

Of the two elements that jointly determine the magnitude of the assessed valuation of a district, that of the valuation procedure is the most difficult to specify and analyze. The method used for valuing the property base to which the rate of levy is applied differs widely among existing districts and within individual districts over time despite the legal stipulation that district assessment shall be levied upon the unimproved land valued at its full cash value as of the first Monday in March of each year.[1]

A complete survey of the valuation methods followed in all districts is outside the scope of this study but valuation procedures used include the following:

1. Flat rate obtaining to all land assessed within the district.
2. Sets of valuation rates, applied according to land and water use.
3. Sets of valuation rates, applied according to the location of a particular parcel of land with respect to certain center points.
4. Sets of valuation rates, applied according to relative elevation of separate land parcels.
5. Sets of valuation rates, applied according to relative soil characteristics of individual land parcels.

Earlier practices frequently adopted either a flat value rate for all land or used some fraction of the value assigned for purposes of county taxes. These

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1/ State of California, California Water Code, Section 25503.

earlier practices generally have been modified to make allowance for land of different agricultural productivity potential. This transition has been particularly marked in those districts that receive water from the federal government under contract.

Before executing any contract with an irrigation district, the Bureau of Reclamation is required to make a study of those districts requesting contract. These studies, made under the title of Factual Studies, include estimates of the districts' ability in contract repayment computed by partial residual budgeting methods for typical crop practices on land of differing soil characteristics. In a number of instances, the soil classification maps of the districts employed in the Factual Studies have been adopted by the districts themselves for computing the valuation of individual land parcels within the district boundaries for assessment purposes.[1/] District applicants for loans under Public Law 130 are similarly reported upon by the Bureau of Reclamation also making available to the district soil classification data.

The divergence between actual practice of irrigation districts and the specifications of the law in the matter of property valuation has been noted. Although court cases have arisen in connection with district assessment, these have almost entirely dealt with the right of certain lands to be exempted of such assessments and not on the legality of a particular method of land valuation practiced by a particular irrigation district.

It is probable that the principle of "stari discisus" would prevail in actual court contest. This would uphold the legality of present practices by virtue of the extensive period of time during which they had been used, indicating the present inapplicability of the initial law. This appears substantiated by a court decision rendered in 1956 holding valid the equalization of assessed

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1/ The Madera Irrigation District has adopted this method of valuation.

valuation of lands in the Oroville-Wyandotte Irrigation District by a formula adopted by the district's board of directors.[1/]

The aggregate value of property within irrigation districts subject to district assessment has demonstrated considerable change over the 1930-1956 period. The total period covered shows a net increase in total assessed valuation of approximately 50 per cent--from just under $223,000,000 in the initial year to over $334,000,000 in 1956. (See Figure No. VIII.) This aggregate value fell off substantially during the 1930's reflecting the substantial assessment default experienced during that time. A similar trend is discernible in the total rate of district assessment levy over this same depression period. Thus, the decline in district assessment revenue was due to a reduction of the valuation placed on district lands as well as the total rate of levy imposed on this value base.

From Table 6 it is seen that over the 1930-1956 period, 38 of the 71 districts on which data are available increased their property valuation while some 25 districts underwent a net decrease of assessed valuation. There was a general tendency for individual districts to have undergone reductions in the property valuation during the depression years and increases during the subsequent years.

During the interval 1930-1935, approximately 90 per cent of all districts undergoing change decreased the valuation of the property subject to district assessment. This trend was substantially reduced during the ensuing five-year interval with the proportion of districts reducing their assessed valuation dropping to about two-thirds of those undergoing change.

1/ See California State Board of Equalization, Annual Report of State Board of Equalization for the Year 1956-57 (Sacramento, 1957), p. 39. Reed vs. Oroville-Wyandotte Irrigation District, 114 Cal. Appl 2d 16. The formula raised the value of all lands valued over a designated amount. It also resulted in a reduction by 75 per cent of the assessor's valuation of all parcels of commercial and residential land of less than 1 acre in area, but in no case were such lots to be valued at less than $100.

FIGURE VIII

Total Assessed Valuation and Average Assessed Valuation Per Acre
Assessed for All California Irrigation Districts, 1930-1956

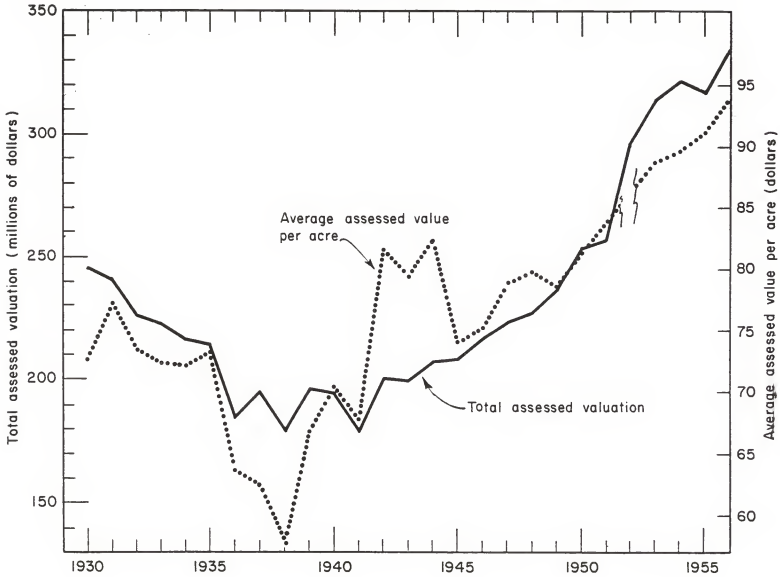

Figure VIII continued.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931). (Bulletin No. 21-B.)

Ibid., 1931 (Bulletin No. 21-C).

Ibid., 1932 (Bulletin No. 21-D).

Ibid., 1933 (Bulletin No. 21-E).

Ibid., 1934 (Bulletin No. 21-F).

Ibid., 1935 (Bulletin No. 21-G).

Ibid., 1936 (Bulletin No. 21-H).

Ibid., 1937 (Bulletin No. 21-I).

Ibid., 1938 (Bulletin No. 21-J).

Ibid., 1939 (Bulletin No. 21-K).

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1941 (Bulletin No. 21-M).

Ibid., 1942 (Bulletin No. 21-N).

Ibid., 1943 (Bulletin No. 21-O).

Ibid., 1944-1950 (Bulletin No. 21-P).

Robert C. Kirkwood, State Controller, Annual Report of Financial Transactions Concerning Irrigation Districts of California, Calendar Year 1951, Calendar Year 1952 (Sacramento: State Printing Office, 1954).

Ibid., 1953.

Ibid., 1954.

Ibid., 1955.

Ibid., 1956.

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TABLE 6

Changes in the Assessed Valuation of California Irrigation Districts, 1930-1956

Year-interval	Districts on which data are available	Districts undergoing change	Districts increasing assessed valuation	Districts decreasing assessed valuation	Districts undergoing no change
1930-1956	71	63	38	25	8
1930-1935	71	61	8	53	10
1935-1940	70	59	23	36	11
1940-1945	72	58	52	6	14
1945-1950	76	56	50	6	20
1950-1955	84	67	57	10	17

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931) (Bulletin No. 21-B).

Ibid., 1935 (Bulletin No. 21-G).

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1944-1950 (Bulletin No. 21-P).

Robert C. Kirkwood, State Controller, Annual Report of Financial Transactions Concerning Irrigation Districts of California, Calendar Year 1955 (Sacramento: State Printing Office, 1956).

Ibid., 1956.

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During the early years of World War II, this trend was reversed. From 1940-1945 only six districts underwent a net decrease in their reported assessed valuation figures while 52 such districts indicate a net increase, with 14 remaining unchanged. This reversal of trend has been maintained throughout the ensuing years, although during the latest five-year period, 1950-1955, it has been somewhat reduced.

While these data are useful in indicating in gross terms the general trends over time, for comparative purposes the assessed valuation must be put on a per-acre basis. These data are synthetic values as they represent mathematical averages and, hence, will deviate from actual per-acre assessed valuation due to differences in the per-acre value of different land parcels within the district.

Over the entire period 1930-1956, almost all districts on which data are available underwent a change in their average valuation per acre. The majority experienced a net increase, paralleling the state assessed valuation. (See Table 7.) The five-year interval 1930-1935 also reflects the comparable change in total valuation as the majority of the districts reduced the average valuation per acre.

During these five years, 40 districts underwent a net decrease, and only 20 showed a net gain in average acre assessed valuation. From 1935-1940 about half of the districts for which data are available indicate a gain with 31 districts showing a net increase per acre over the interval. From 1940-1945, 39 California districts increased the average acre assessed valuation with 21 experiencing a net decrease. From 1945-1950 only 13 districts had a net decrease while the majority, 44, again demonstrated an increase in this average valuation. From 1950-1955, of the 69 districts for which information is available, 54 increased and 15 decreased their average valuation per acre for district assessment purposes.

Considering the total period of analysis, 1930-1956, data on both total assessed valuation and the average assessed value per acre assessed indicate

TABLE 7

Changes in Assessed Value Per Acre for California Irrigation Districts[a] 1930-1956

Year-interval	Districts on which data are available	Districts undergoing change	Districts increasing assessed value per acre	Districts decreasing assessed value per acre	Districts undergoing no change
1930-1956	64	64	40	24	0
1930-1935	71	60	20	45	11
1935-1940	67	61	30	31	6
1940-1945	66	57	44	13	9
1945-1950	70	60	39	21	10
1950-1955	80	69	54	15	11

a/ Per-acre average assessed valuation represents simple means, computed from data on the total assessed valuation and the number of acres assessed of individual irrigation districts. They are not weighted to account for different rates of assessed valuation used by an individual irrigation district in any particular year.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931) (Bulletin No. 21-B).

Ibid., 1935 (Bulletin No. 21-G).

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1944-1950 (Bulletin No. 21-P).

Robert C. Kirkwood, State Controller, Annual Report of Financial Transactions Concerning Irrigation Districts of California, Calendar Year 1955 (Sacramento: State Printing Office, 1956).

Ibid., 1956.

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

similar changes--approximately two-thirds of those districts that underwent change increased the valuation for district assessment purposes. In considering each of the five-year intervals that comprise this period, we find that during certain intervals, the number of districts increasing their per-acre assessed valuation differs substantially from the number calculated on the basis of total assessed valuation of the district as a whole. For example, during the five-year interval 1930-1935, 8 districts increased their total assessed valuation while 20 districts increased their per-acre average. Conversely, during the interval 1940-1945, some 52 districts increased their total assessed valuation while 44 increased the average assessed valuation per acre assessed.

Those data for the decade of the 1930's are explained by a less than proportional decrease in land area subject to district assessment, assuming equal valuation for irrigated lands within a given district.[1/] Data for the three 5-year intervals from 1940 to 1955 indicates the majority of districts changing their assessed value per acre experiencing an increase, showing a less than proportional increase in acreage assessed relative to the total assessed valuation of districts.

The Total Rate of Levy.--The total rate of levy is established annually by the board of directors of each irrigation district. Its composition is accounted for by the several funds into which the financial transactions of California irrigation districts are separated. In some districts separate rates of levy are enumerated under each of these individual funds, while in others these are

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1/ As indicated above, data on acres assessed are not available prior to 1940. An estimate of this has been made by deducting from gross acreage the area held by the district under tax deed, representing an upper ceiling below which the actual areas assessed lie. If the assumption of equal valuation procedures for each acre valued for district assessment is relaxed and a differential system of valuation admitted, and assuming a generally uniform economic impact of the national depression upon a given district, there would be a tendency for those lands on which the high per-acre district assessment were incident to be among the first to default and, hence, come under district ownership through tax deed.

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aggregated into a single rate of levy for the district as a whole. Of the several determinants of the assessment bill of irrigation districts, the rate of levy lends itself most conveniently to periodic change. Indeed, the annual changes in this rate of levy within individual districts show substantially higher year-to-year relative variation than does either the acreage assessed or the assessed valuation per acre of California irrigation districts.1/

1/ Over the 15-year period 1940-1955, ten randomly selected irrigation districts had coefficients of variation given in the following table. The coefficient of variation, a measure of relative dispersion, is given by the formula:

$$V = \left(\frac{\sigma 2}{\bar{X}}\right) 100$$

Coefficients of Variation

District	Acres assessed	Total rate of levy	Average valuation assessed per acre
Alta	1.55	38.06	4.68
Byron-Bethany	.66	10.78	2.86
Compton-Delevan	0.00	33.50	0.00
Exeter	3.67	25.19	20.34
Glenn-Colusa	12.31	21.48	2.42
Lindmore	2.59	45.58	1.81
Porterville	0.34	43.22	16.46
Romona	0.00	18.02	59.45a/
Tranquility	.55	14.91	2.13
Waterford	3.63	19.48	4.01
Average	2.53	27.02	11.42

a/ This high variation is accounted for by a change in valuation procedure adopted in 1946 and again in 1952.

Sources:

Compiled from data in California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931) (Division of Water Resources Bulletin No. 21-B); 1931 (Bulletin No. 21-C); 1932 (Bulletin No. 21-D); 1933 (Bulletin No. 21-E); 1934 (Bulletin No. 21-F); 1935 (Bulletin No. 21-G); 1936 (Bulletin No. 21-H); 1937 (Bulletin No. 21-I); 1938 (Bulletin No. 21-J); 1939 (Bulletin No. 21-K); 1940 (Bulletin No. 21-L); 1941 (Bulletin No. 21- M); 1942 (Bulletin No. 21-N); 1943 (Bulletin No. 21-O); and 1944-1950 (Bulletin No. 21-P).

See also California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1951-1955 (Sacramento, 1958) (Bulletin No. 21).

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The total rate of levy for district assessment over the period 1930-1956 demonstrates a net decrease. This change is reflected both in terms of the average of the total rates of levy used by all California irrigation districts and also in terms of the number of such districts undergoing a decrease in the rate of levy used as compared with districts whose rate of levy increased or remained the same throughout the 1930-1956 period. (See Table 8.) The general decrease in the total rate of levy over the period 1930-1956 closely parallels the relative decrease in receipts from district assessments with respect to receipts from water sales previously noted.

Changes in the total rate of levy that took place during the five-year intervals of the period covered indicate the impact both of the national depression and management and administrative problems with which California irrigation districts have been faced in the post World War II years.

The five-year interval 1930-1935 witnessed a substantial number of districts in which the total rate of levy employed for district assessment decreased. Of the 63 districts that underwent a net change over this interval, 51 decreased and 12 increased the total rate of levy. This tendency is reflected also in the drop of the average of the total levy rate used by all California irrigation districts from $5.10 to $3.65 per $100.00 assessed valuation between 1930-1935.[1/]

This average of total rate of levy dropped still further during the 1935-1940 interval from $3.65 to $2.67. However, a similar decline is not reflected

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1/ California Department of Public Works, Division of Water Resources, op. cit., 1930 (Bulletin No. 21-B); 1931 (Bulletin No. 21-C); 1932 (Bulletin No. 21-D); 1933 (Bulletin No. 21-E); 1934 (Bulletin No. 21-F); 1935 (Bulletin No. 21-G); 1936 (Bulletin No. 21-H); 1937 (Bulletin No. 21-I); 1938 (Bulletin No. 21-J); 1939 (Bulletin No. 21-K); 1940 (Bulletin No. 21-L); 1941 (Bulletin No. 21-M); 1942 (Bulletin No. 21-N); 1943 (Bulletin No. 21-O); 1950 (Bulletin No. 21-P).

See also California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts . . .

TABLE 8

Changes in Total Assessment Levy Per $100 for California Irrigation Districts, 1930-1956

Year-interval	Districts on which data are available	Districts undergoing change	Districts increasing assessment levy	Districts decreasing assessment levy	Districts undergoing no change
1930-1951	70	68	19	49	2
1930-1935	67	63	12	51	4
1935-1940	66	43	25	18	23
1940-1945	67	47	37	10	20
1945-1950	76	55	40	15	21
1950-1955	82	61	40	21	21

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931) (Bulletin No. 21-B).

Ibid., 1935 (Bulletin No. 21-G).

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1944-1950 (Bulletin No. 21-P).

Robert C. Kirkwood, State Controller, Annual Report of Financial Transactions Concerning Irrigation Districts of California, Calendar Year 1955 (Sacramento: State Printing Office, 1956).

Ibid., 1956.

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in the number of districts undergoing a net change over the same interval. Of the 43 districts that experienced a change, 25 or almost 60 per cent of these increased the total rate of levy, while 18 districts decreased this rate of levy. Those districts which had established a relatively high rate of assessment levy during the initial year of the 1935-1940 period made substantially larger reductions in the rate of levy relative to those districts with lower rates during the initial year of the same interval.[1/] This appears to be a direct reflection of the delinquency problems facing high-levy districts during this time.

From 1940 to the present, there was an initial increase in the average total rate of levy of all districts followed by a leveling off of the trend since 1950. (See Figure No. IX.) From the standpoint of those districts undergoing change, the majority experienced a net increase over each of the three 5-year intervals of the period. This reversal of the earlier trend may be visualized as an adjustment of the rate of levy after the impacts of the depression and the war years, reflecting the financial reorganization that many districts underwent during the late 1930's. Such refinancing resulted in the reissuance of new district bonds and subsequent increases in the rate of levy represented by the bond interest and redemption fund of those refinancing districts. This is especially evident in the data for the 1940-1945 interval.

The Use of Water Tolls by California Irrigation Districts

The water toll is the second component of the payment made by members to their district. The type of water cost that a particular toll represents, and

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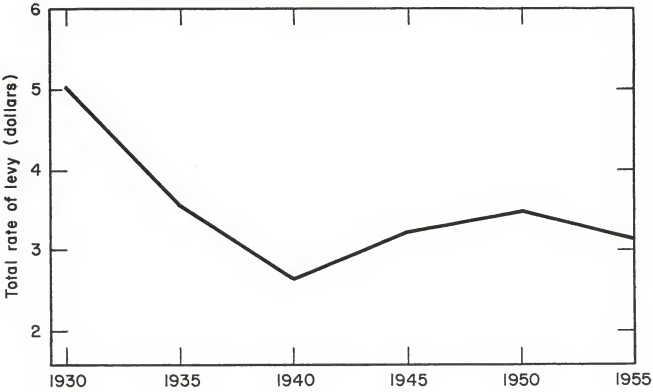
1/ A linear regression fit was made of 66 California irrigation districts in which the following relationship was found to obtain

$$X_1 = \underset{(2.884)}{18.069} - \underset{(3.168)^2}{4.551X_2}$$

where X_1 - percentage change in the total rate of levy over the 1935-1940 interval, and X_2 - the total rate of levy employed by the district during the year 1935 (dollars per $100 assessed valuation).

FIGURE IX

Average Total Rate of Levy per $100 Assessed Valuation for All California Irrigation Districts, 1930-1955



Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931). (Bulletin No. 21-B.)

Ibid., 1935 (Bulletin No. 21-G).

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1944-1950 (Bulletin No. 21-P).

California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1951-1955 (Sacramento, 1958). (Bulletin No. 21.)

its functional relationship with quantity delivered, if any, will depend upon the unit base to which such a toll is applied and the specific conditions according to which it is calculated.[1] Because of the diversity of expression of the water toll, it has not been possible to present comparable data on the actual toll rates used by different irrigation districts. Furthermore, information relating to water tolls employed by each district has not been published during the period of analysis with the exception of 1930, 1931, and 1932. Consequently, data relating to the magnitude of district water sales receipts, or the aggregate water tolls collected by a district in a particular year are analyzed for indications of this aspect of district pricing behavior.[2]

Total receipts from the sale of water by California irrigation districts over the period of analysis, 1930-1956, increased from under 2.5 to over 14 million dollars.[3] In addition, the receipts from water sales have become more significant relative to total district receipts. In 1930 sales receipts constituted 18 per cent of the total revenue secured by all active irrigation districts. In 1956 this figure increased to 31.54 per cent. (Figure No. X.) Similarly, water

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1/ As we have seen, several California irrigation districts use sets of water tolls, that is, different unit tolls become effective at various levels of use. In some districts this is established on an acre basis and in others on an acre-foot-of-water basis.

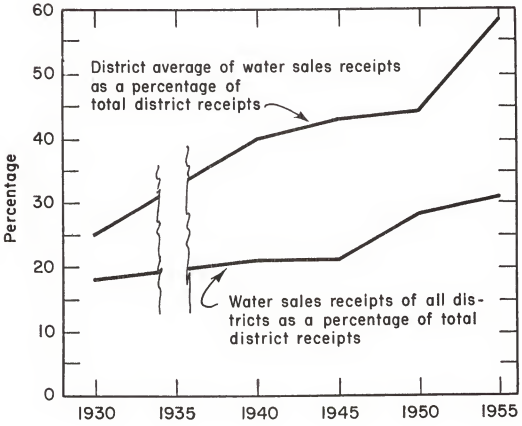
2/ It is to be noted that total district revenues have been calculated, excluding those revenues secured from the sales of bonds and time warrants. Such transactions, while relevant to the pricing decisions of the district, do not themselves comprise components of the payment complex.

3/ Computed from data in California Department of Public Works, Division of Water Resources, op. cit., 1930 (Bulletin No. 21-B); 1931 (Bulletin No. 21-C); 1932 (Bulletin No. 21-D); 1933 (Bulletin No. 21-E); 1934 (Bulletin No. 21-F); 1935 (Bulletin No. 21-G); 1936 (Bulletin No. 21-H); 1937 (Bulletin No. 21-I); 1938 (Bulletin No. 21-J); 1939 (Bulletin No. 21-K); 1940 (Bulletin No. 21-L); 1941 (Bulletin No. 21-M); 1942 (Bulletin No. 21-N); 1943 (Bulletin No. 21-O); 1944-1950 (Bulletin No. 21-P).

See also California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts . . .

FIGURE X

Water Sales Receipts of All California Irrigation Districts as a Percentage of Total District Receipts and District Average of Water Sales Receipts as a Percentage of Total District Receipts, 1930-1955



a/ Excludes district receipts from bond and time warrant sales.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931). (Bulletin No. 21-B.)

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1944-1950 (Bulletin No. 21-P).

Robert C. Kirkwood, State Controller, Annual Report of Financial Transactions Concerning Irrigation Districts of California, Calendar Year 1955 (Sacramento: State Printing Office, 1956).

sales receipts as a percentage of total income for 47 individual irrigation districts increased over the period, while it decreased in only 7 such districts. (Table 9.)

Over the interval 1930-1940, some 39 districts increased the ratio of water sales receipts to total district revenue, in contrast to 13 for whom this ratio decreased. This trend is counter to that of district assessment. In the face of the widespread assessment default by district members that characterized the 1930-1940 interval and the consequent lower total receipts to most irrigation districts, water sales receipts would necessarily tend to account for a higher percentage of the total district receipts.1/ Since 1940 the proportion of total district receipts comprised of water sales increased gradually to just under 60 per cent in 1955. This and additional quinquennial data indicating the district average of water sales receipts as a percentage of total district revenues throughout the 1930-1955 period are illustrated in Figure No. X. It is noted that the former set of data consistently lie above the latter, reflecting the fact that those districts with relatively large revenues secured a proportionally lower percentage of this from water sales receipts than did smaller districts. This discrepancy has become increasingly larger in more recent years.

Certain observations can be made on the use of the water toll by different groups of irrigation districts. Two types of groupings have been made and differences in the use of the water toll by these groups analyzed.

The first consists of two groups defined on the basis of the functions performed by districts: districts providing domestic water supplies to their membership and districts that generate and sell electricity in addition to providing

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1/ Although it is legally possible for districts to refuse water service to members defaulting on assessment payments (State of California, California Water Code, Section 22250) during the depression years, few districts invoked this practice. With many of the districts themselves in financial difficulties on their bond obligations, they generally attempted to make water sales whenever possible.

TABLE 9

Changes in Per Cent of Total District Income[a] From Water Sales Receipts in California Irrigation Districts, 1930-1956

Year-interval	Districts on which data are available	Districts undergoing change	Districts increasing per cent from sales	Districts decreasing per cent from sales	Districts undergoing no change
1930-1956	54	54	47	7	0
1930-1940	53	52	39	13	1
1940-1945	51	51	27	24	0
1945-1950	55	55	38	17	0
1950-1955	67	67	47	20	0

a/ Excludes district receipts from bond and time warrant sales.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931) (Bulletin No. 21-B).

Ibid., 1940 (Bulletin No. 21-B).

Ibid., 1944-1950 (Bulletin No. 21-P).

Robert C. Kirkwood, State Controller, Annual Report of Financial Transactions Concerning Irrigation Districts of California, Calendar Year 1955 (Sacramento: State Printing Office, 1956).

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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their members with a supply of irrigation water. Figure No. XI indicates the average percentage of total district receipts from water sales of districts in these two groupings as well as the average of all irrigation districts in California.

Domestic water sales are included in the water sales receipts data, and as these are universally higher per acre-foot than the sales receipts from irrigation water,[1] it is expected that the percentage of total receipts from water sales of these districts would be larger than the state average. Those districts engaging in the generation and sale of electricity, on the other hand, customarily transfer net returns from this operation to their water accounts thereby permitting substantial reductions in the payment complex used for their irrigation water supply. This reduction occurs primarily in the water toll component, as seen in Figure No. XI.

The second grouping of irrigation districts is made on the basis of district size. Similar data are presented in Figure No. XII pertaining to districts in excess of 75,000 acres and less than 8,000 acres. The larger districts characteristically have relatively low percentages of their total receipts from water sale, while the smaller districts have a higher than average percentage of this total from such sales.

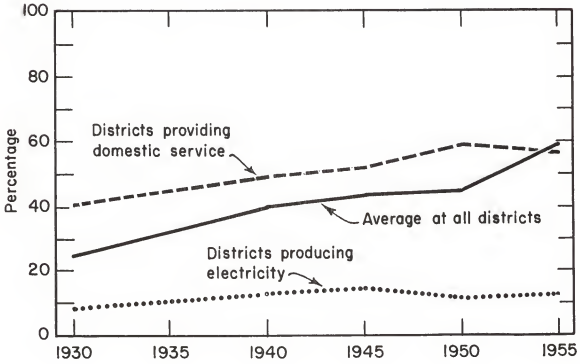
1/ Although districts customarily use a per-month or per-year toll for domestic water, several do employ comparable volume units for these tolls. In 1950 the following tolls were used per hundred cubic feet for irrigation and domestic water by districts providing both services:

District	Domestic water toll	Irrigation water toll
San Ysidro	$0.17	$0.06
Sausalito	0.10	0.04
South San Joaquin	0.19	0.025

Data from the files of the California Districts Securities Commission and the Federal Land Bank, Berkeley, California.

FIGURE XI

Water Sales Receipts as a Percentage of Total Receipts[a] for California Irrigation Districts Producing Electricity and Providing Domestic Water Supply, 1930-1955



a/ Excludes district receipts from bond and time warrant sales.

Sources:

California Department of Public Works, Division of Water Resources Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931). (Bulletin No. 21-B.)

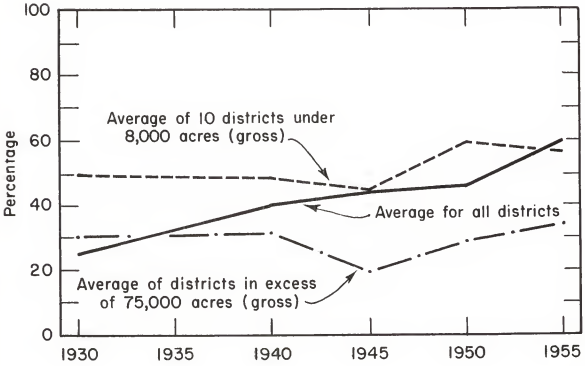
Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1944-1950 (Bulletin No. 21-P).

California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1951-1955 (Sacramento, 1958). (Bulletin No. 21.)

FIGURE XII

Water Sales Receipts as a Percentage of Total Receipts[a] for Large[b] and Small[c] California Irrigation Districts, 1930-1955



a/ Excludes district receipts from bond and time warrant sales.

b/ Includes all districts in excess of 75,000 gross acres.

c/ Data from 10 randomly selected districts from the 39 in the size class 0 to 8.000 gross acres.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931). (Bulletin No. 21-B.)

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1944-1950 (Bulletin No. 21-P).

California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1951-1955 (Sacramento, 1958). (Bulletin No. 21.)

These data primarily reflect difference in the size of assessment base for districts in each group. In addition smaller districts characteristically have a higher proportion of their area under irrigated cultivation. As discussed in Chapter V, a payment complex comprising a high assessment component relative to water tolls tends to promote this result.

Changes in the Total Payment Complex

Changes in both the average assessment levied by districts and the average water sales receipts per acre-foot of water delivered within the district boundaries is presented in Figure No. XIII. The sum of assessments levied and sales receipts per acre-foot declined rapidly during the early 1930's to a low in 1938. From that year, an irregular increase has occurred to a high of $3.25 in 1955. Looking at the components of this sum, the relative significance of the average water sales receipts per acre-foot delivered has increased materially. In 1930 this constituted approximately 20 per cent of the total increasing to over 50 per cent by 1955.

This trend reflects the generally increasing significance of district administrative and operation and maintenance expenses. The size of these expenses has been highly correlated with the water tolls of districts since 1940.[1/]

1/ The following correlation coefficients were computed for all California irrigation districts for which data were available for the 1940-1956 period:

Year	r_{xy}	Year	r_{xy}
1944	.884	1950	.889
1945	.814	1953	.838
1947	.919	1956	.738

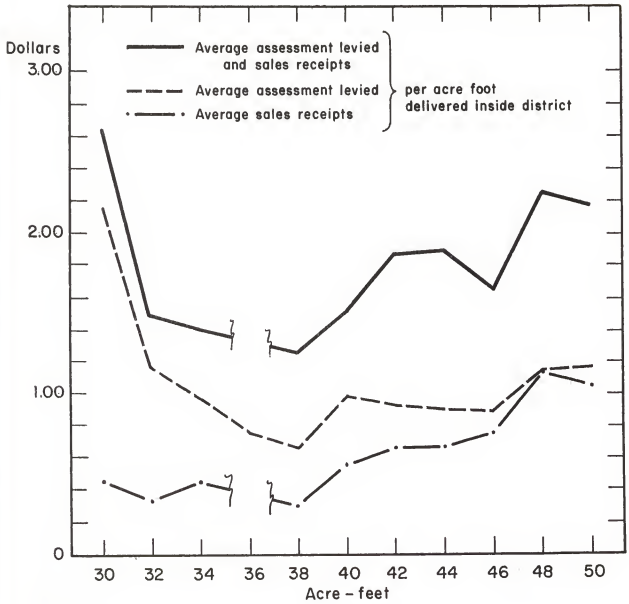
where x = district receipts from water sales, and y = district expenditures on administration and on operation and maintenance.

See California Department of Public Works, Division of Water Resources, op. cit., 1930 (Bulletin No. 21-B); 1931 (Bulletin No. 21-C); 1932 (Bulletin No. 21-D); 1933 (Bulletin No. 21-E); 1934 (Bulletin No. 21-F); 1935 (Bulletin No. 21-G); 1936 (Bulletin No. 21-H); 1937 (Bulletin No. 21-I); 1938 (Bulletin No. 21-J); 1939 (Bulletin No. 21-K); 1940 (Bulletin No. 21-L); 1941 (Bulletin No. 21-M); 1942 (Bulletin No. 21-N); 1943 (Bulletin No. 21-O); 1944-1950 (Bulletin No. 21-P).

See also California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts . . .

FIGURE XIII

Average Assessment Levied and Sales Receipts Per Acre-Foot of Water Delivered Inside California Irrigation Districts, 1930-1950



Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931). (Bulletin No. 21-B.)

Ibid., 1932 (Bulletin No. 21-D).

Ibid., 1934 (Bulletin No. 21-F).

Ibid., 1938 (Bulletin No. 21-J).

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1942 (Bulletin No. 21-N).

Ibid., 1944-1950 (Bulletin No. 21-P).

California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1951-1955 (Sacramento, 1958). (Bulletin No. 21.)

A regional segregation of districts was made and differences in the total payment complex of the regionally grouped districts analyzed over the period 1945-1955. Three areas were delineated as indicated in Figure No. XIV. Each of the regions are characterized by different physical and economic factors.

Area 1 comprises counties in the Sacramento Valley and is characterized by a relative abundance of water. This area has considerably more runoff than either of the other two areas. The ground water of this region is generally higher than that of the others, and the over-all cost of irrigation water is less in this part of the state than in either of the other areas considered.

Area 2 comprises the highly agricultural counties of Fresno, Kings, San Joaquin, and Tulare. This area has a lower mean seasonal precipitation and a considerably greater depth to ground water than Area 1. Four districts situated in the San Joaquin Valley produce and sell electrical energy in addition to providing members with a supply of irrigation water.

Area 3 is difficult to characterize. The south coastal plain has undergone a major transition in land use, and accompanying this, in the uses to which water has been put. The municipal and residential expansion just prior to and during World War II is well known, and the phenomenon of housing projects in the midst of former citrus groves often has been cited. The general level of water cost in this area has been high relative to other parts of the state.

Districts situated in Area 1 have been characterized by the highest percentage of total district receipts in the form of water tolls. The regional average increased from 43 per cent in 1945 to 60 per cent in 1955. (See Table 10.) During 1945 and 1950, the average acre assessed valuation of districts in this area was the lowest of the three areas considered, but the total rate of levy applied to this assessed valuation was the highest. Between 1950 and 1955, the regional average of per-acre assessment increased from 3.16 to 5.20.[1/] This

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1/ 1950: $\frac{71.00}{100} \times 4.46 = 3.16$ 1955: $\frac{179.00}{100} \times 2.91 = 5.20$. Computed from data in Table 10.

FIGURE XIV

Area Classification

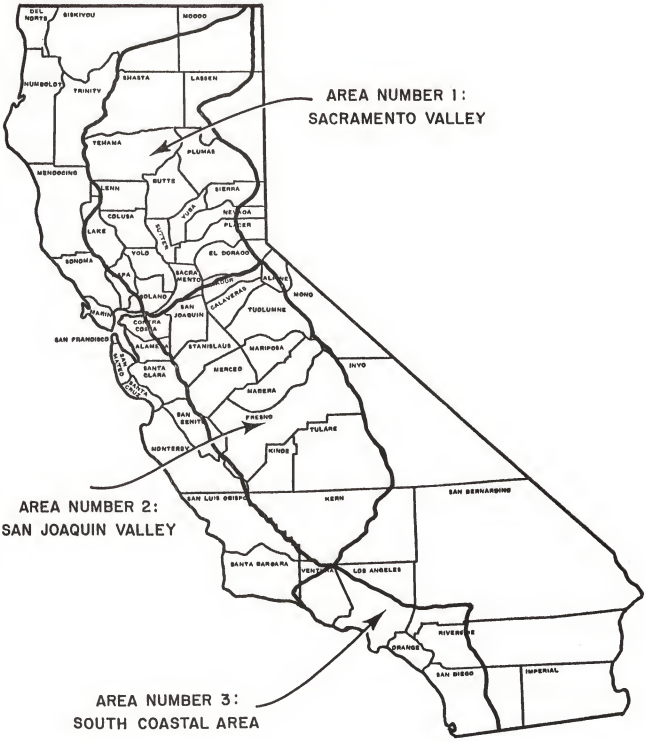

TABLE 10

Average Regional Characteristics of California Irrigation Districts, 1945-1955[a]

Area	Districts analyzed			Assessed valuation per acre[b]			Total rate of levy[c]			Water sales receipts as a per cent of total receipts[d]		
	1945	1950	1955	1945	1950	1955	1945	1950	1955	1945	1950	1955
	number			dollars						per cent		
1	15	17	16	61	71	179	4.35	4.46	2.91	43	54	60
2	18	27	29	98	98	100	3.69	3.72	3.58	36	33	48
3	12	13	12	427	445	643	3.61	3.74	3.91	48	47	56

a/ Regional average of per-acre assessment for Area 1 for 1950 computed as follows:

$$\frac{71.00}{100} \times 4.46 = 3.16$$

b/ Data are means of the per-acre valuation for individual districts within each area.

c/ Data are means of total rate of levy employed within each district of each area.

d/ Data are means of the percentages for individual districts.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year, 1944-1950 (Sacramento, 1951) (Bulletin No. 21-P).

Robert C. Kirkwood, State Controller, Annual Report of Financial Transactions Concerning Irrigation Districts of California, Calendar Year 1955 (Sacramento: State Printing Office, 1956).

increase took the form of an increase in average assessed valuation by more than 100 per cent and a decrease in the total rate of levy of from 4.46 to 2.91 dollars per hundred dollars assessed valuation in 1950 and 1955, respectively. This is markedly different from districts in the other areas which underwent increases in both assessed valuation and rate of levy over this ten-year period.

Area 2 districts situated in the San Joaquin Valley have employed relatively stable water pricing practices from 1945 to 1955. The percentage of total district receipts from water sales has been consistently lower than the average of districts in the other two areas--36 per cent in 1945 increasing to 45 per cent in 1955. Location of a number of districts who generate electricity in this area is reflected in this lower average. Both of the determinants of the district assessment have been relatively stable over the ten years covered with an average valuation of approximately $100 per acre and a total rate of levy of approximately 3.70 per $100 assessed valuation. In analyzing this stability, it should be remembered that two periods of time may be distinguished--pre-1950 and 1950-1955. During the first of these subperiods, districts in Area 2 obtained their water supplies from appropriative rights held on the various streams on the east side of the San Joaquin Valley. Although subject to variation with the precipitation cycles, this source of water constituted a relatively stable quantity. During the 1950-1955 period, however, districts in this area received considerable additional water under contract from the Central Valley Project.[1/] The stability

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1/ In 1950 the following quantities of water supplied irrigation districts in this area from the Central Valley Project:

1950 water deliveries from Madera Canal:	116,000 acre-feet
1950 water deliveries from Friant-Kern Canal:	183,000 acre-feet

In 1955 deliveries were increased to the following quantities:

1955 water deliveries from Madera Canal:	213,000 acre-feet
1955 water deliveries from Friant-Kern Canal:	790,000 acre-feet

Above data are from the files of Land and Water Use Section, U. S. Bureau of Reclamation, Sacramento, California, obtained in November, 1958.

[illegible]

[illegible]

[illegible] In 1970 the [illegible] [illegible]

[illegible]

of the per-acre assessment of these districts throughout these two subperiods indicates the use of a payment complex with a relatively higher water toll component for this additional water. As discussed later in the study, under contract conditions, the use of a payment complex with a high water toll component holds advantages in reducing the uncertainty associated with the future supply of water delivered under contract to a district.

Area 3 districts have derived approximately one-half of their total receipts from water sales. The assessment component of the payment complex of these districts demonstrates a high per-acre assessed valuation in relation to districts elsewhere in the state. Their total rate of levy, on the other hand, has approximated that of districts in the San Joaquin Valley. Because many of the districts in this area use ground sources for their water supplies, the costs of water per acre-foot delivered to members traditionally has been substantially higher than in other areas.1/

A characteristically high assessed valuation of district land in this region has been noted since the 1920's,2/ as have large discrepancies between the assessed valuation of urban as opposed to agricultural land. As the total rate of levy

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1/ The average cost to members per acre-foot of water supplied by their irrigation districts in 1922 has been estimated as follows:

Average for districts in northern California per acre-foot:	3.43
Average for districts in central California per acre-foot:	3.55
Average for districts in southern California per acre-foot:	8.61

Computed from California Department of Public Works, Division of Water Resources, Cost of Water to Irrigators in California (Sacramento, 1957).(Bulletin No. 8.)

2/ See data on assessed valuation of Beaumont, Madera. Fallbrook, San Dieguito, and Lakeside irrigation districts in Adams, op. cit., pp. 290-295, 297, 305, and 314.

generally is applied across-the-board to all district land,[1] differences in assessed valuation are the only way in which the incidence of the district assessment can be varied. The large discrepancies in valuation in this area result in the shift of a substantial portion of the district assessment to such urban land.

IV. THE WATER ALLOCATION EFFECTS OF DISTRICT PRICING BEHAVIOR

Water is an economic factor of production. As such, its use will be influenced by the costs and returns associated with alternative lines of use and ways of employment within single lines of use. The allocative effects of the pricing practices of California irrigation districts represent adaptive responses by individual irrigators to the cost structure of their total water supply. This supply may consist of that water made available to them by the district alone; or, more commonly, it may comprise sources additional to that of the district. These two situations have important analytical differences, but the district payment complex influences both. This chapter considers the relationship between the payment complex and the cost structure for water facing individual district members and the relationship between changes in this structure and water use.

Irrigation districts employ the water supplies they develop in three principal ways: irrigation, domestic use, and water export. Of these three, irrigation is and has been the largest single use to which district supplies have been devoted. (See Figure XV.) Changes in domestic use of district water over time as discussed in Chapter II appears unrelated to the pricing practices adopted. This function was assumed by districts largely in the absence of other organizations

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1/ The one exception to an across-the-board application of the total rate of levy is that the components of the total rate, attributable to improvement districts are incident only upon land within these internal districts. Such improvement districts have been used primarily to extend the distribution systems of irrigation districts and, consequently, are most prevalent in larger districts. Those in the south coastal plain are relatively small and not characterized by such improvement districts.

FIGURE XV

Water Deliveries and Losses of California Irrigation Districts, 1930-1955

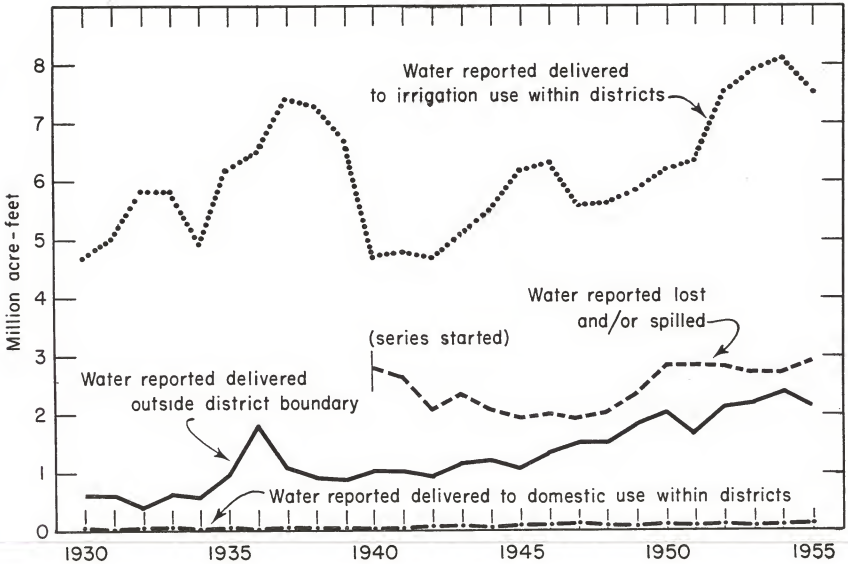

Figure XV continued.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California for the Year 1930 (Sacramento, 1931). (Bulletin No. 21-B.)

Ibid., 1931 (Bulletin No. 21-C).

Ibid., 1932 (Bulletin No. 21-D).

Ibid., 1933 (Bulletin No. 21-E).

Ibid., 1934 (Bulletin No. 21-F).

Ibid., 1935 (Bulletin No. 21-G).

Ibid., 1936 (Bulletin No. 21-H).

Ibid., 1937 (Bulletin No. 21-I).

Ibid., 1938 (Bulletin No. 21-J).

Ibid., 1939 (Bulletin No. 21-K).

Ibid., 1940 (Bulletin No. 21-L).

Ibid., 1941 (Bulletin No. 21-M).

Ibid., 1942 (Bulletin No. 21-N).

Ibid., 1943 (Bulletin No. 21-O).

Ibid., 1944-1950 (Bulletin No. 21-P).

California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1951-1955 (Sacramento, 1958). (Bulletin No. 21.)

more specifically designed to provide this service, and relatively high water tolls have been charged for this service. Thus, domestic water service may be regarded as a causal factor in the determination of district pricing practices rather than a consequence. The quantity of water export, however, is more directly related to district pricing policy and is considered at the end of the present chapter.

Costs and Decisions

From the standpoint of an irrigating district member, the problem of water use entails the selection of a combination of water use alternatives consistent with as large as possible net returns. This is a typical problem of farm management, and economic theory is helpful in indicating relevant variables and their interrelationships.

The microproblem here suggested is one of determining the least cost combination of factors to be used in the production of each crop grown and the combination of crops or enterprises that maximizes the net returns of the entire farm unit. Orthodox theory tells us that net returns are maximized when the marginal value product of a factor used in production of one product equals the marginal value product of its use in alternative employment and that the marginal value product of its use in all employment equals its marginal unit cost. Changes in either of these two conditions may be brought about by changes in the price received for crops grown or changes in the costs of factors of production.[1/] Change in the price received for crops will tend to shift production in favor of the relatively higher priced crop. Similarly, considering an enterprise production function by itself in which factor substitution is technically possible,

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1/ As the problem here is considered instantaneously, changes in the function coefficient are irrelevant. For a discussion of the function coefficient, see Sune Carlson, A Study on the Pure Theory of Production (New York: Kelly and Milliman, Inc., 1956, reprint), p. 17.

[illegible]

if the ratio of factor costs changes, the least cost combination of factors will entail the substitution of relatively "cheaper" factors for the more dear factors. If all inputs are perfectly divisible, an actual change is expected. If there are lumpy inputs, this may not be reflected empirically if the range of adjustment is small. The tendency toward such change nevertheless exists so long as maximum net returns remains the decision criterion. Limitations upon the number of response alternatives are determined by the factor cost ratios, the technical possibilities of factor substitution, and limitations on factor supply.

Actual observation indicates no consistent relationship between changes in the size of water tolls and crops planted. Crop report data on three irrigation districts that underwent substantial change in this variable cost component of their payment complex from 1950 to 1955 indicate no discernible trend toward shifting out of higher water-using crops to those requiring lower amounts of applied water, with increases in the average variable cost, or reverse changes, associated with decreases in the water toll component. (See Table 11.)

Two factors lend insight into this lack of relationship. These are the small proportion of the total variable cost of most irrigated crops represented by the irrigation water input and the relative stability of the average variable cost of irrigation water from year to year.[1/] Table 12 presents data on water costs for ten irrigated crops. Irrigation water costs average 10 per cent of the total variable cost of production for the group. In addition, those districts that have available water from additional sources are affected by changes in the variable cost of water delivered by the district only if its marginal cost is less than the marginal costs of securing a comparable supply from other sources.

All current costs incurred in the use of irrigation water affect the net returns to be derived from a particular irrigated crop. Insofar as district water is used for irrigation by a member, its variable cost--that is, those costs

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1/ See Chapter III, Figure XIII.

TABLE 11

Summary Crop Data Report for Three Irrigation Districts

	Orange Cove Irrigation District						Madera Irrigation District					Lindmore Irrigation District				
	1955	1954	1953	1952	1951	1950	1954	1953	1952	1951	1950	1954	1953	1952	1951	1950
District water toll per acre-foot (dollars)	3.80	3.50	3.50	3.50	1.50	1.50	2.75	2.50	3.25	1.75	1.75	5.50	5.50	5.50	6.00	2.50
Acreage of high water use factor crops a/ as a percentage of total irrigated acreage of district	5.9	6.2	5.9	6.0	4.2	5.8	32.1	31.4	25.4	21.3	21.9	10.3	7.9	5.9	4.8	7.7
Acreage of medium water use factor crops b/ as a percentage of total irrigated acreage of district	9.6	11.1	8.2	5.3	4.7	--c/	6.0	3.5	1.8	1.8	6.2	38.0	46.2	47.7	40.5	25.7
Acreage of low water us use factor crops d/ as a a percentage of total irrigated acreage of districts	9.6	11.1	8.2	5.3	4.7	---	6.0	3.5	1.8	1.8	6.2	---	---	.8	1.4	15.8

a/ High water use factor crops: alfalfa and irrigated pasture.

b/ Medium water use factor crops: cotton and grapes.

c/ Dashes indicate no data available.

d/ Low water use factor crops: vegetable and truck; grain and grain hay.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California, 1944-1950 (Sacramento, 1951). (Bulletin No. 21-P.)

California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1951-1955 (Sacramento, 1958). (Bulletin No. 21.)

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[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	[illegible]	[illegible]
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[illegible]

TABLE 12

Variable Cost of Water as Per Cent of Total Variable Cost of Production of Selected Crops[a]

	Cotton[a]	Alfalfa[b]	Potatoes[c]	Grapes: Thompson seedless[d]	Grapes: Emperor[d]	Field corn[b]	Barley[e]	Ensilage corn[e]	Pasture[c]	Rice
	1	2	3	4	5	6	7	8	9	10
Water applied in inches	36	44.4	31.2			36	10.8	24	60	f/
Variable water cost per acre[g] (dollars)	10.26	12.65	17.52	8.56	9.99	10.26	2.54	5.64	12.30	8.50
Total variable cost per acre (dollars)	187.12	73.55	439.00	197.85	371.40	93.65	24.09	82.72	53.43	56.90
Water as a per cent variable cost (dollars)	5.4	17.2	4.0	4.3	2.7	10.9	10.5	6.8	23.0	14.9

a/ Data pertain to the east side of San Joaquin Valley, California.

b/ Data pertain to 80-acre farm.

c/ Data pertain to 160-acre farm.

d/ Data pertain to 30-acre farm

e/ Data pertain to 320-acre farm.

f/ No data available.

g/ Variable cost of ground water pumping--including amortisement, repair, maintenance, lubrication, and power--except for data on rice. Variable cost for water for rice irrigation was the water tolls of an irrigation district.

(Continued on next page.)

[illegible]

[illegible]

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table 12 continued.

Sources:

Cols. 1-3 and 6-9: Douglas D. Caton, Trimble R. Hedges, and W. Neill Schaller, Farm Adjustments and Earnings Under 1955 Cotton Acreage Allotments--Central San Joaquin Valley Cotton Farms, 1953-1955, University of California, Giannini Foundation Mimeographed Report No. 208 (Berkeley, July, 1958).

Cols. 4 and 5: D. C. Athanassatos and Hedges, Farm Adjustments and Earnings Under 1955 Cotton Acreage Allotments--Small Grape Farms on the San Joaquin Valley Eastside, 1953-1955, University of California, Giannini Foundation Mimeographed Report No. 194 (Berkeley, May, 1957), 76p.

Col. 10: Gordon R. Sitton, Sacramento Valley Rice Farms--Organization, Costs and Returns, University of California, Giannini Foundation Mimeographed Report No. 207 (Berkeley, July, 1958), 135p.

functionally related to the quantity used--and physical limitation are directly related to a member's decision of whether and how much district water to use. This variable cost is established annually by the payment complex. When additional water is available to members of a district, the current costs of these alternatives also affects the decision. These two situations, however, are distinctly different and warrant separate analytical treatment.

Single-Source Districts

In California, few irrigation districts are entirely single-source districts. Many members may not use an alternative source in a given year, but few districts are characterized by members that have not undergone the initial investment[1/] required to make one available. In these few districts there has been relatively little uncertainty surrounding the expectation that the marginal cost of district-delivered water is below that of water from an alternative source over that range of output for which the marginal value product of water is greater than the marginal unit cost of district water. These conditions are met in two types of districts--those in which the marginal unit cost of district water is rendered very low by the pricing practice adopted by the district; and districts where the physical characteristics entail a relatively high marginal unit cost of alternative water. Examples of the former are found on the east side of the San Joaquin Valley in which the revenue from the sale of electricity generated by the district is used to service and redeem bonded indebtedness as well as to pay for current operation, maintenance, and administrative expenses. Several southern California districts are situated so that the high costs of ground water pumping or acquiring nondistrict-provided surface water have rendered them single-source districts.

1/ In the instance of the alternative being pumped ground water, the initial investment is incurred by drilling a well and acquiring pumping facilities. If the alternative source is surface water, initial outlay is involved in diversion and distribution facilities, and perhaps pumping equipment if other than gravity-flow water is involved.

[illegible]

[illegible]

[illegible]

Members of a single-source district have, in the aggregate and individually, fewer alternative ways by which they may obtain a supply of irrigation water. However, even in a single-source district, individual members may have alternatives. Frequently, members are afforded the use of district facilities to make intermember water transfers. A district may permit the unrestricted use of its distribution facilities--that is, members make their sales and purchase arrangements individually, requesting the district to withhold and deliver the quota involved at the time agreed upon.[1] Each member receives a district bill as though the transfer had not taken place, and the "purchase" is settled individually between the seller and buyer. More frequently, however, the individual members wishing to sell their quota are required to report this to the district engineer who also receives purchase requests. Reapportionment of deliveries is then planned by the district engineering staff in such a way that it does not interrupt the basic delivery schedule. The need for such a restricted exchange is more evident in districts with relatively limited system capacity and employing rotational systems of delivery. In at least one instance, the district also determines the price of such transfers. Annual district bills of both buyer and seller are adjusted by adding the district assessment levy of the seller to that of the buyer for the particular year in which the transfer took place.[2] If fractions of district quotas are involved, then a similar proportion of the assessment bill is transferred.

For individuals within single-source irrigation districts, water use decisions are made upon the basis of the established payment complex for a given

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1/ This is the case in the Turlock Irrigation District. See Article 13 of Turlock Irrigation District, Rules and Regulations of the Turlock Irrigation District (Turlock, California: Board of Directors, Turlock Irrigation Districts, 1957). Mimeographed.

2/ In the Fresno Irrigation District, transfer between individual district members is handled by the district office. These arrangements are made annually to protect against possible development of prescriptive rights among district members. (Interview.)

year. Although one may speculate that there is a temporal connection between the composition and magnitude of one year's payment complex and that of subsequent years, through repayment requirements or administrative commitment, no evidence was found for such an assertion. If such were indeed the case, the annually fixed cost of district assessments might become variable as disinvestment in land entered into the longer run decision context.

The Variable Cost of District Water

The average variable cost, as well as the marginal cost, of district water supply is determined by the water toll. California irrigation districts employ one of two bases on which water toll charges are calculated. These are a unit volume of water, usually an acre-foot or a rate of flow per time interval; and an area base usually specified in terms of per acre irrigated by district water. The first of these two bases is the most generally used. When it is, the average variable cost and marginal cost functions are identical, comprising a horizontal line, or horizontal components, up to the limit that water from this source is available. This function often is discontinuous as, for example, in the Turlock Irrigation District. Deliveries to members up to 4 acre-feet per acre bear no variable cost, but water in excess of 4 feet per acre bears a total of $1 per acre-foot.1/

When the area base is used for water tolls, the average variable cost for district water is a decreasing function. If only one unit of district water is used, this unit must bear the entire cost of the toll, whereas additional volumes are consumed per acre of irrigated land, the cost per water unit decreases. This type of charge establishes a per-acre average cost function of a hyperbolic form. The marginal unit cost associated with these circumstances is zero.

1/ Turlock Irrigation District, op. cit., Article 1F.

[illegible]

When an area toll base is used, an individual irrigator will tend to use district supplied water to the maximum possible quantity or at the quantity that represents an optimum[1] irrigation for the crops being cultivated, whichever is smaller, on each acre irrigated by district water. The basic decision alternative will be to use district water at that quantity on a particular acre of land or to use no district water. The irrigator may decide to use water from a combination of sources on a given acre; but so long as any district water is used, he will tend to use it to the maximum with water from other sources being supplementary to the district supply.

One common form of area based water toll used by California irrigation districts entails a different charge, depending on the crops being grown.[2] This type of practice may produce an average variable cost function for water that is equivalent to a volume unit toll or it may discriminate between the production of different crops. If the ratio of such crop differentiated toll is proportional to the quantities of irrigation water applied on specific crops, and the full quantity applied is obtained from the irrigation district, this type of toll will result in similar charges for a given volume unit to all irrigators using district supply regardless of the crop grown.[3] However, if a set of charges on a crop-acre

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1/ The choice criterion is the maximum net returns per acre. Under this type of toll, there is no marginal cost of acquiring water once a decision to use is made. The optimum will thus approximate the maximum physical yield. As a positive marginal cost of application (labor) may be assumed, the economic optimum will be somewhat less than the physical optimum.

2/ This practice is followed by the Woodbridge, Glenn, Colusa, and Nevada irrigation districts.

3/ This, for example, is approximated by pricing practices of the James Irrigation District, which has a per-acre per irrigation charge for cotton and irrigated pasture and employs a per-acre water toll for rice. The rates used for the 1958 growing season are as follows:

Cotton	$ 2.00 per irrigation per acre
Irrigated pasture	$ 1.50 per irrigation per acre
Rice	$26.00 per acre per season

In the district, cotton is usually irrigated six times a season, with an average of 5 inches applied in each irrigation; irrigated pasture is customarily irrigated on an average of 12 to 14 times, with a total use of approximately 4½ feet of applied water; and rice averages 6 feet of water per season. On the basis of the water tolls in current use, the comparable acre-foot water toll amounts to the following:

Cotton	$4.80
Irrigated pasture	$4.00-$4.66
Rice	$4.33

Information from district files and interview with Mr. Kerr, Manager, James Irrigation District, June, 20, 1958.

base are not proportional to the applied water, the price of a water unit will differ between use for different crops in the irrigation district--a form of discriminatory pricing by the district as among crop types.[1]

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1/ The Jacinto, Maxwell, Princeton-Codora-Glenn, and Provident irrigation districts provide an example of this. The following table indicates the water duty and the water toll per crop-acre of four crop types as a percentage of that of rice in each district for the year 1955.

For crop-acre water tolls to represent an equal volume unit charge, toll ratios would have to equal water application ratios. As can be seen, none of the four districts considered actually meet these requirements. If we assume that these districts supply sufficient irrigation district water to meet the required application of water for all of these crop types, the effective variable cost per water unit is less in all districts for alfalfa, irrigated pasture, and other crops than it is for rice. This disparity between the unit prices is greater in the Jacinto Irrigation District than it is within the Provident Irrigation District, especially in the comparison between the price of a unit volume of water applied to rice and that applied to irrigated pasture.

Crop type	Acre-feet of applied irrigation water	Water tolls per crop-acre			
		Jacinto	Maxwell	Princeton-Cordua-Glenn	Provident
	feet depth	dollars			
Rice	4.1	8.00	8.00	10.00	8.00
Alfalfa	3.7	--	--	5.00	--
Irrigated pasture	3.7	--	--	6.50	5.75
Other a/	2.0	2.25	3.00	--	2.50
	Percentage of water duty and water toll for rice				
Rice	1.00	1.00	1.00	1.00	1.00
Alfalfa	.90	--	--	.50	--
Irrigated pasture	.90	.44	--	.65	.72
Other a/	.49	.28	.38	--	.31

a/ This crop category water duty is an average of data for truck crops, hay, and grain, sugar beets, and miscellaneous field crops.

Source: Water toll data from the files of the California Districts Securities Commission and the Federal Land Bank of Berkeley. Water duty data compiled from regional estimates. See California Water Resources Board, Water Utilization and Requirements of California (Sacramento, 1955), vol. 1, pp. 169-171. (California Water Resources Board Bulletin No. 2.)

Multiple-Source Districts

The multiple-source irrigation district is characterized by members who have available sources of irrigation water other than that provided them by their district and to which the payment complex applies. A district may operate wells, divert surface water from an appropriative filling, and import Central Valley Project water. In spite of these physically distinct sources, the payment complex obtains to all deliveries to members and hence this would be considered a single-source district if no additional supply is available to members. It is to be noted that the several potential sources of irrigation water must be sufficiently comparable in terms of quality and timing to be substitutes in irrigation agriculture.

A problem arises in the designation of multiple-source districts. If a single member of a district has a ground water pumping facility and thereby several sources for irrigation water, is the district a multiple-source district? The issue is one of degree. It is not unimportant, however, as a multiple-source district may adopt particular pricing policies specifically designed to influence the use of nondistrict as well as district sources. An example of such a district is discussed below.

Decisions by district members as to which of several possible sources is preferred and whether that source is used in conjunction with or exclusive of other alternatives depends upon their relative costs and quantity limitations.[1/] The relevancy of particular cost items depends on the time dimension of the decision being faced.

The payment complex establishes the cost structure for district water and is fixed annually. Ground water is the most common alternative source of irrigation water available to members. The costs of this water include initial capital

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1/ A quantity limitation may be implicit in fixed delivery quotas used in a rotation delivery system.

[illegible]

[illegible]

costs of a well, equipment, and installation as well as current operating and maintenance costs. The capital outlay for well and equipment is customarily amortized over its lifetime. The length of life of a well and pump may be related to use, although this is not common. Usually the depth, texture of the material in which the well is drilled, and the type of pump will determine the lifetime of such capital equipment. Under these circumstances, annual amortization becomes a variable cost only if the decision entails a time horizon that is longer than the lifetime[1] of such equipment.

The Variable Cost of Ground Water

For an irrigation farm with a well, pump and motor, the principal components of the total variable cost of water--or those costs that vary with water use--are the power cost, lubrication, and repairs on the pumping plant. Capital depreciation costs and insurance costs recur annually and are unrelated to pump delivery. Of these three components of variable cost, power is the largest

The power cost consists of a stand-by charge and a kilowatt-hour charge for actual power used. The stand-by charge is a fixed sum that is paid if the plant is operated at all during a season and varies with the horsepower rating of the particular pump on which it is incident.[2] This schedule results in a discontinuous standy-by charge function of linear segments for different horespower connected loads.

1/ The life of well, casing, pump, and motor varies greatly. Differences in expected lifetime of pumping equipment installed in Kern County in 1957-1959 varied from 3 to in excess of 20 years. (Interview, Jacuzzi Bros., Inc., Richmond, California, November, 1958.)

2/ Stand-by charges currently used by the Pacific Gas and Electric Company (PG and E) are as follows:

Connected load (horsepower)	Annual service charge per horsepower (cents)
2- 4.9	8.83
5- 14.9	7.46
15- 49.9	6.73
50- 99.9	5.99
100- 249.9	5.26
250- 499.9	5.26
500- 999.9	5.05
1,000-2,499.9	4.73

[illegible]

[illegible]

[illegible]

The power charge relates to the cost to the operator of the kilowatt hours used by the pump each season. This, too, varies with the horsepower rating of the motor used as well as with the total kilowatt hours used.[1/]

Lubrication costs have been found to equal approximately 1 per cent of the sum of service charge and power bill.[2/] Repairs have constituted a small percentage of the total variable cost of pumping ground water and have averaged 23 cents an acre-foot in the east side of the San Joaquin Valley.[3/] These data

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1/ The power in kilowatt hours required to pump one acre-foot of water is given by:

(1) $KWH = 1.024 \frac{H}{E}$, where H is the head, or total feet of lift, and E is the over-all efficiency of the pump plant expressed as a decimal. This efficiency is determinable by test.

The total kilowatt-hour charge component of power cost may be expressed by the following formulae:

(2) $a \cdot (r \cdot KWH)$, if $KWH < 1{,}000$
(3) $1{,}000\ ar + br(KWH - 1{,}000)$, if $KWH > 1{,}000$ and $< 2{,}000$
(4) $1{,}000\ ar + 1{,}000\ br\ cr(KWH - 2{,}000)$, if $KWH > 2{,}000$
where KWH is the total kilowatt hours consumed, r is the horsepower rating of the motor, and a, b, and c are energy charges. Current PG and E, energy charges are given by the following:

PG and E Agricultural Power Schedule PA1, Effective November 12, 1957
in all Areas Except Around Santa Cruz

r	a	b	c
	cents		
2- 4.9	1.85	.91	.65
5- 14.9	1.59	.91	.65
15- 49.9	1.49	.91	.65
50- 99.9	1.38	.91	.65
100- 249.9	1.33	.91	.59
250- 499.9	1.28	.91	.59
500- 999.9	1.22	.91	.59
1,000-2,499.9	1.22	.91	.59

2/ Douglas D. Caton, Trimble R. Hedges, and W. Neill Schaller, Farm Adjustments and Earnings Under 1955 Cotton Acreage Allotments, San Joaquin Valley, Eastside Cotton Farm, 1953-1955, University of California, Giannini Foundation Mimeograph Report No. 202 (Berkeley, 1952), see footnote 6, p. 41.

3/ Ibid., pp. 36 and 41. Calculated from total repair on pumping plant and total acre-feet pumped.

were obtained on motors with an average horsepower rating of 30 h.p. With larger motor units, this repair figure given can be considered as a maximum.

The ground-surface water-use results of district pricing practices are illustrated on the east side of the San Joaquin Valley. Many districts situated in this area obtain water from both surface streams and pumping. Irrigated agriculture within these districts almost universally employ individually owned pumping plants to supplement district water deliveries. The heavy draft upon the ground water reservoirs of the area has been reflected by increasing depths to water in most of these districts,[1] many of which now are receiving additional water from the Friant-Kern Canal of the Central Valley Project.

Most of the districts receiving water from this canal have attempted to induce the substitution of district-delivered surface water for pumped ground water. To implement this substitution, the variable unit cost component of the payment complex--the water toll--has been established lower than that for pumped ground water. Table 13 indicates the relative average variable costs per acre-foot for district deliveries and ground water within six irrigation districts deriving a portion or all of their water supply from the Madera or Friant-Kern canals.

The objective for such substitution is to reduce and stabilize the cost of the total water supply available to the area served by these districts. Important sources of cost instability derive from fluctuations in the quantity of water delivered by the Central Valley Project and fluctuations in member demand for district water. Central Valley Project deliveries to districts are subject to annual fluctuation. During years of low precipitation , less than a district's contracted quota may be delivered, requiring a supplementary supply of ground water, the variable unit cost of which is a function of the depth it must

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1/ G. H. Davis, J. H. Green, F. H. Olmstead, and D. W. Brown, Ground Water Conditions and Storage Capacity in the San Joaquin Valley, California (Sacramento: State Printing Office, 1957), pp. 167-168. (U. S. Geological Survey Open File Report.) Mimeographed.

TABLE 13

Variable Cost of District and Ground Water Pumped from Farm Wells for Six California Irrigation Districts

District	1957 district water toll per acre-foot	1956 Average lift of ground water	Average variable cost of ground water per acre-foot
	1	2	3
	dollars	feet	dollars
Madera	2.50	84	3.36
Shafter-Wasco	4.50	163	6.52
Exeter	5.00	102	4.08
Lower Tule River	2.20	96	3.84
Ivanhoe	3.00	87	3.48
Tulare	1.50	98	3.92

Sources:

Col. 1: Data obtained from interview with district personnel.

Col. 2: Data obtained from U. S. Bureau of Reclamation, Water Supply, 1956 (Fresno: Operation Office, 1956), Plates 5, 11, 15, 23, and 32. Mimeographed.

Col. 3: Computations assume a pumping cost of 4 cents per acre-foot per foot of lift, as reported in U. S. Bureau of Reclamation, Factual Report Delano-Earlimart Irrigation District, Central Valley Project, California (Fresno: Operation Office, 1950), p. 24. Mimeographed.

TABLE 17

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

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[illegible]

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be pumped. The greater the depth to ground water, the higher the cost of total supply to district members and the greater the absolute fluctuation of cost associated with variable delivery from the Central Valley Project.

Delivery contracts between the district and the federal government require annual payments by districts for their full entitlement, regardless of annual changes in member demand for water from their district.[1/] Although rather extensive water transfer opportunities physically are available through the Friant-Kern Canal system, contracting districts can at best cover the cost of unused portions of their annual deliveries which they export.[2/] The probability of a district being able to sell export water at a price equal to the cost initially incurred by the contractee is not high.[3/] Member demand for district water in a multiple-source district is derived water demand, depending ultimately upon the decisions by members to irrigate a given area of specific crops. The actual decision of what quantities will be used from the multiple sources available is resolved on the basis of comparative variable unit cost. To the extent that the district is successful in inducing the substitution of district-delivered surface water for pumped ground water, fluctuation in member demand is reduced.

1/ Customarily, the contractee is given an initial "development period," during which annual change may be made in the quantity of delivery made. After such a period, usually two to three years in duration, annual changes are made against the district according to its full quota. See U. S. Bureau of Reclamation, Contract Between the United States and the Shafter-Wasco Irrigation District Providing for Water Service and for the Construction of a Distribution System (Sacramento, 1950). Mimeographed. (From the files of the Fresno Operations Office of the U. S. Bureau of Reclamation, dated February 11, 1955.)

2/ See page 103.

3/ Those years in which total water supplies available to any one district--its contract quota and other sources of supply--are excessive will also be years when supplies tend to be excessive to all districts. Periods of relatively high export demand and excess supply thus tend to be offsetting.

The Experience of the Lower Tule River Irrigation District

In order to examine the impact of price on district and ground water use in greater detail, we shall consider the Lower Tule River Irrigation District, which is situated in the service area of the Friant-Kern Canal.

The district, shown in Figure XVI, is located in the south central portion of Tulare County and comprises 102,817 acres. The Tule River runs through the district which lies below and is one of the larger irrigation districts served by the Friant-Kern Canal.

Upon formation in 1950, it became apparent to the board of directors that the district entitlement to surface water from the Tule River[1] was inadequate for a reliable annual water supply to the district and that supplemental water from the Friant-Kern Canal was desirable. In 1951, the district signed a contract providing for 40,000 acre-feet of Class I and 270,000 acre-feet of Class 2 water.[2]

In 1955, negotiations were reopened with the Bureau of Reclamation, and a new contract was signed in 1957. This provided for 61,000 acre-feet of Class 1

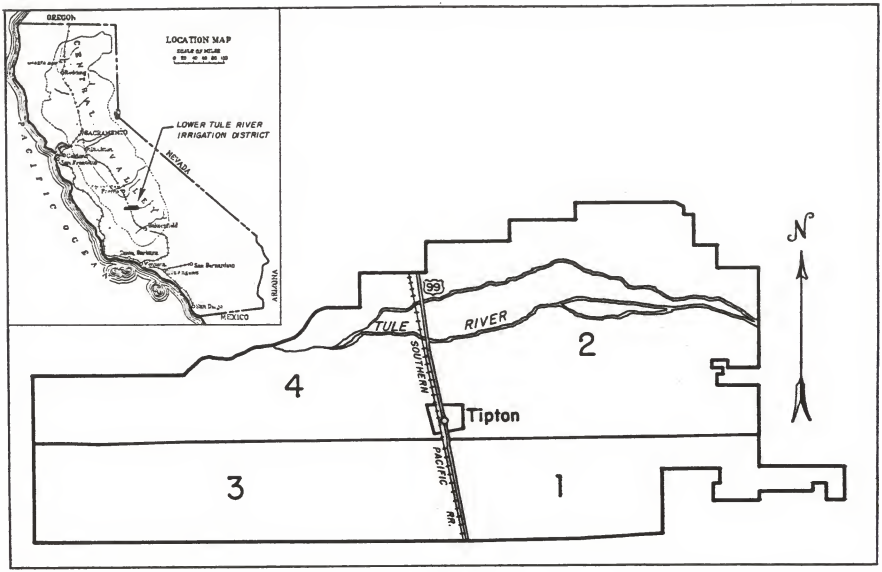
1/ The Bureau of Reclamation estimates that the average annual water supply available to the Lower Tule River Irrigation District from the Tule River is approximately 57,200 acre-feet. If equally apportioned to the 81,107 acres reported irrigated within the district in 1955, this would mean an average of 0.7 acre-feet per irrigated acre within the district from Tule River sources. U. S. Bureau of Reclamation, Lower Tule River Irrigation District, Water Supply (Fresno: Fresno Operations Office, February, 1955). Mimeographed.

2/ Class 1 water is defined as "that supply of water at Friant Dam and Reservoir which will be available for delivery from the Friant-Kern and Madera canals and the San Joaquin River as a dependable water supply during each irrigation season." Class 2 water is defined as "that supply of water which becomes available in addition to the supply of Class 1 water and which, because of its uncertainty as to availability and time of occurrence, will be undependable in character and will be furnished only if, as, and when such water is available as determined by the United States." U. S. Bureau of Reclamation, Contract Between the United States and the Lower Tule River Irrigation District Providing for Water Service (Sacramento, 1950). Mimeographed. (From the files of the Fresno Operations Office of the U. S. Bureau of Reclamation.)

[illegible]

FIGURE XVI

The Lower Tule River Irrigation District



and 238,000 acre-feet of Class 2 water. The district engineer has calculated that its annual supply of Class 2 water annually will average 50 per cent of its total entitlement.[1]

The history of ground water conditons under the present irrigation district has been extremely varied. Aquifers in the eastern part of the district have been reported as generally shallow, unconfined, and yield water of good agricultural quality.[2] The base of this zone varies from 150 to 300 feet. In the western portions of the district, good quality water is found at greater depths, is confined, and is subject to hydrostatic gradient movement. Mendenhall, in 1916, undertook the earliest ground water studies in the San Joaquin Valley which estimated a depth to water in the area of the Lower Tule River Irrigation District of from less than 5 to more than 30 feet, the average being approximately 15 feet.[3] Average depths to ground water within the district during the period 1925-1955 are presented in Figure XVII.

The variable costs of ground water have, of course, varied with these changes. The costs of energy, lubrication, and repair on an acre-foot-delivered basis have been computed for four subsections within the Lower Tule River Irrigation District. (See Table 14.) In this calculation, it was assumed that all units delivered 378 acre-feet annually, which figure represents the average annual delivery quantity as determined by the Bureau of Reclamation in the 1954 survey of 131 pumps within the district.[4]

1/ William Alexander, Lower Tule River Irrigation District, History and Operational Report, 1950 to 1957 (Woodville, California, 1958), p. 5.

2/ U. S. Bureau of Reclamation, Lower Tule River Irrigation District . . ., p. 16.

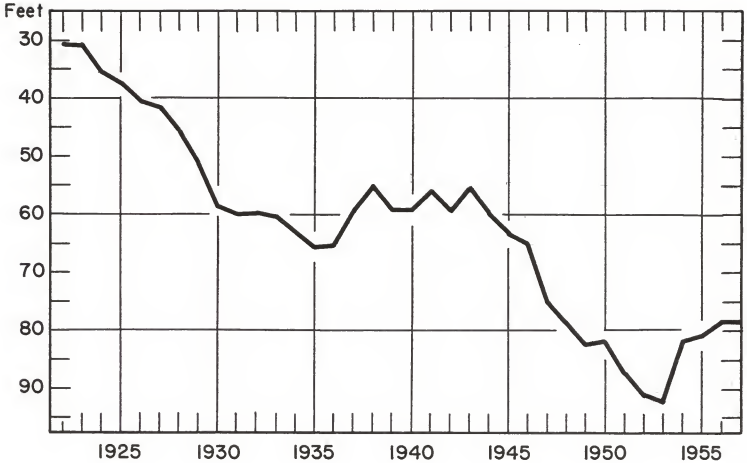
3/ W. C. Mendenhall, R. S. Doyle, and H. Stabler, Ground Water in the San Joaquin Valley, California, U. S. Geological Survey, Water Supply Paper No. 398 (Washington: U. S. Government Printing Office, 1916).

4/ U. S. Bureau of Reclamation, Lower Tule River Irrigation District . . ., p. 22.

[illegible]

FIGURE XVII

Average Mean Seasonal Depth to Water, Lower Tule River Irrigation District, 1922-1957



Source: W. A. Alexander, Lower Tule River Irrigation District, History and Operational Report, 1950 to 1957 (Woodville, California: 1957) p. 17. Mimeographed.

TABLE 14

Maximum, Mean, and Minimum of Average Cost[a] Per Acre-Foot Pumped in Subareas of the Lower Tule River Irrigation District (1957 Seasonal High Depth to Water)

Subareas	Average total variable cost		
	Maximum	Mean	Minimum
	dollars		
1	4.73	4.31	3.90
2	3.45	2.71	1.96
3	4.04	3.01	1.97
4	5.19	3.80	3.40

a/ Includes stand-by charge, cost of energy used, lubrication, maintenance, and repair. Power cost computed from Pacific Gas and Electric rate schedule, effective November 12, 1957.

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Since 1954, the Lower Tule River Irrigation District has established a payment complex with a toll component of $2.20 per acre-foot. The district clearly stated that this was for the express purpose of inducing property owners within the district to purchase surface water and correspondingly reduce their pumping so that the ground water reservoir beneath the district might be replenished.[1/] The district management further has indicated its intent to maintain the replenishment program until district ground water depth averages from 40 to 30 feet. In other words, the pricing practices in this district purposefully have been employed to induce a predetermined allocative result that would have desirable effects from the standpoint of district water management.

Assessment of the physical results of this program is difficult since no quantitative records are maintained on the pumped ground water within the district. The change in ground water level, however, demonstrates a less rapid decline in the years 1950-1952; and an actual decrease in depth to water in the years subsequent to 1952 reflects the shift from ground to surface water use over this period.

Water Export

The use of a district's supply of irrigation water for purposes of water export is related to the pricing practices of multiple-source districts. Their pricing practices affect the internal demand for water from this source; and as district demand holds a legal priority over export, district pricing simultaneously affects the supply of exportable water.

The quantity of water diverted by irrigation districts that is subsequently delivered to areas outside the boundaries of such districts has gradually increased from just over 500,000 acre-feet in 1930 to over 2,000,000 acre-feet in

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1/ Alexander, op. cit., p. 19.

[illegible]

[illegible]

[illegible]

1955. (See Figure XV above.) A single district, the Imperial Irrigation District, accounts for approximately 80 per cent of this total water export.[1]

The remainder of the water classed as "exported" consists of water exchanged between districts and nondistricts entities. These transactions are generally on an annual basis to preclude jeopardizing district water rights by prescriptive loss. However, a few contracts running for a series of years have been found.[2]

The possibility of water sales on a market outside the boundaries of the irrigation district appears to present a dual market situation of which the district might take advantage through multiple pricing.[3] In actuality, a number of factors make this possibility quantitatively insignificant.

1/ Of the total water exported by all irrigation districts, Imperial accounted for the following percentages:

1955--93.5	1945--85.1	1935--76.8
1950--81.9	1940--82.7	1930--84.6

California Department of Public Works, Division of Water Resources, op. cit., 1930 (Bulletin No. 21-B); 1932 (Bulletin No. 21-D); and California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts . . .

This district has reported water exports that are approximately equal to the quantity used for irrigation purposes within the district. A major portion of this export quantity is accounted for by the operations of the All American Canal. The 1932 All American Canal contract between the Bureau of Reclamation and the Imperial Irrigation District provides for the diversion by the district of waters to be delivered to the Yuma and Bard projects of the Bureau of Reclamation. In 1955, the amount of water diverted to these two federal projects was 1,300,000 acre-feet, or 70 per cent of the reported export water of the district. See Imperial Irrigation District, op. cit., p. 16.

2/ For example, the Lower Tule Irrigation District entered into agreement providing for annual water export with the Crockett and Gambogy interests who operated a pumping field in the district prior to district formation. This contract was formalized in 1956 and provides for the maximum five-year average annual quantity and an annual maximum extraction which cannot be exceeded. See Alexander, op. cit.

3/ If the two markets are separate with no leakage and the elasticities of demand differ, a multiple pricing arrangement, according to the formula:

$$P_i = \frac{\text{marginal revenue}_i}{1 - 1/e_i}$$

where i = district market, external market and e_i = the elasticity of demand with respect to price, would maximize total water sales receipts to the district. See Joan Robinson, Economics of Imperfect Competition (London: Macmillan and Company, 1933), Chapter 15.

[illegible]

The physical prerequisite for water export--a distribution system--limits the possibilities for sales outside district boundaries. Those districts receiving water from the Central Valley Project are the most favorably situated in this regard,[1] although the multiple-purpose function of the project's impounding structures tends to create a supply circle that runs counter to that for demand.[2] This group of districts, however, is prohibited from reselling any water delivered under contract from the project at a profit.[3] This restriction immediately imposes a $3.50- and $1.50-per-acre-foot ceiling for such water sales. Those irrigation districts not integrated into the Central Valley Project distribution system are in a market situation approaching bilateral monopoly as the potential purchasers are few by virtue of the distribution problem. The uncertainty of the annual quota of export water available precludes major investment in such a distribution system by a potential external purchaser.

Perhaps the most important factor preventing the active emergence of a dual market lies in the very definition of surplus water. The California Water Code merely states that "surplus water" may be exported and sold, specifying that it "be not necessary for use within the district."[4] Although thus far water "needs"

1/ The common canal system to irrigation districts receiving water from the Central Valley Project permits a large number of buyer-seller permutations. Analysis of water export among districts receiving water from the Madera and Friant-Kern canals of the Central Valley Project shows slightly higher export figures than the state average. This discrepancy is augmented considerably if the water export of the Imperial Irrigation District, accountable for by the All American Canal Contract, is deducted from the state average as shown in Table 15.

2/ A primary alternative function of the Friant Dam, which supplies both the Madera and Friant-Kern canals, is flood protection. Because of this, there is a tendency for the water release to be large or exceed average release during years of relatively high precipitation. These are precisely those years in which the demand for irrigation water supplies tends to be less than average. The converse is also true.

3/ Such prohibition of resale at a profit is a characteristic aspect of all contracts between irrigation districts and the Bureau of Reclamation. For example, see U. S. Bureau of Reclamation, Contract Between the United States and the Lower Tule River Irrigation District . . ., Article 4(b), p. 5.

4/ State of California, California Water Code, Section 22259.

TABLE 15

Rate of Water Export for Irrigation Districts in Service Area of Friant-Kern Canal and All Districts, 1947-1955

	To district members	Export	Spill or loss
Total water delivery to Friant-Kern Canal Service area (thousands of acre-feet)			
1947	585.0	32.8	85.4
1950	780.6	59.2	97.8
1952	1,349.9	54.1	301.6
1955	874.4	30.3	190.4
As a per cent of delivery to district members			
1947	--a/	5.6	14.6
1950	--	7.6	12.5
1952	--	4.0	22.3
1955	--	3.5	21.8
State total (thousands of acre-feet)			
1947	5,603.2	1,502.3	1,914.5
1950	6,250.5	2,034.0	2,838.3
1952	7,546.7	2,162.7	2,880.7
1955	7,578.4	2,102.9	2,808.5
As a per cent of delivery to district members			
1947	--	2.7	34.2
1950	--	3.2	45.4
1952	--	2.8	38.2
1955	--	2.8	37.1

a/ Dashes indicate no data available.

Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California, 1944-1950 (Sacramento, 1951). (Bulletin No. 21-P.)

California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1951-1955 (Sacramento, 1958). (Bulletin No. 21.)

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

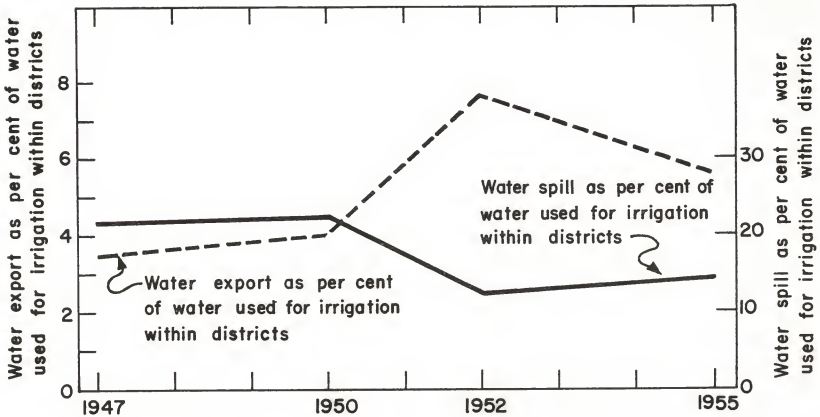
have escaped legal definition, the district organization affords numerous avenues whereby various interpretations may be made articulate. Field interviews indicated extreme convervatism on the part of the boards of directors in the classification of surplus and exportable water regardless of the elasticity of the estimated external demand. Indeed, this very point was cited by district members as the major difference between irrigation districts and mutual or commercial water companies. Water pricing by the latter organizations was seen as an effort to maximize sales receipts under prevailing market conditions, whereas the irrigation district is viewed by its members as a cooperative economic organization providing members with water service at least cost.

In addition to the sentiment of members, many irrigation districts in California engage in water spreading or artificial ground water recharge activities. Although no quantitative measure has been made, it is believed that a high proportion of the "water spill" category is so used. This is especially true of districts in the San Joaquin Valley[1] and southern California. Figure XVIII illustrates the inverse trends in water export and water spill among those districts in the service area of the Madera and Friant-Kern canals from 1947 to 1955. Indeed, as more information is available as to the prospects of recharge on the ground water table level, it may be expected that such recharge activities will be increased, further reducing water export by irrigation districts in the San Joaquin Valley.

1/ Such is the announced policy of the Lower Tule River Irrigation District, which said in a recent report: "It is absolutely essential that we replenish our ground water reservoir and maintain as large a reserve as possible, anticipating deficient years. . . . The district will purchase the maximum quantity of water available each year which it can either deliver on the surface of the ground to the property owners in the district or percolate into the ground water reservoir until such a time that the water table throughout the district averages between 30 and 40 feet below ground surface." See Alexander, op. cit., pp. 12, 31, and 35.

FIGURE XVIII

Water Export and Spill by California Irrigation Districts, 1947-1955



Sources:

California Department of Public Works, Division of Water Resources, Report on Irrigation Districts in California, 1944-1950 (Sacramento, 1951). (Bulletin No. 21-P.)

California Department of Water Resources, Division of Resources Planning, Report on Irrigation and Water Storage Districts in California for 1951-1955 (Sacramento, 1958). (Bulletin No. 21.)

V. AN APPRAISAL OF IRRIGATION DISTRICT PRICING PRACTICES

When price is determined, other than by administrative procedure, often we consider the problem of allocation "solved" in some sense. Yet, frequently the consequences of a market-determined price with respect to the allocation of factors priced may not satisfy an accepted set of efficiency criteria.

In the instance of an irrigation district payment complex which is determined administratively by the board of directors, evaluation must proceed from some defined concept of "efficient" pricing. Efficiency criteria must be related to and, indeed, drawn from the economic role of price. Indeed their consistency with the function of price in the particular organization determines the relevancy of criteria employed. Although the equimarginal principal of efficient resource allocation is valid conceptually, the specification of different lines of production and the period of time embraced by production decisions--or more properly water management objectives--is determined in large part by the institutional environment of these decisions. In addition to technical problems of implementing efficiency evaluation, equity considerations play a major role in group decisions by constituents. Whereas theoretical treatment may consider issues of equity as constraints, subject to which some function is maximized, this is not possible in the analysis of district water pricing. Equity issues consequently are reflected in the evaluatory criteria along with those relating to efficiency.

The Development of Criteria

The pricing practices of California irrigation districts may be appraised from at least two standpoints. A district is an organization pursuing certain ends through decisions that reflect the interaction of constituent interests. A district's behavior, as manifest in the pricing practice adopted, may be appraised in terms of criteria that embody these constituent interests. Such criteria will be called internal criteria. Appraisal is also possible from the standpoint of society in general. This implies an assessment of the degree to

which particular attributes of a district constitute means of facilitating efficient resource allocation and production organization. Criteria to be used in such an assessment are called social criteria.

Internal Criteria

The essentially cooperative nature of the irrigation district has been stressed in an earlier chapter. Although the difficulties surrounding precise economic specification of cooperative objectives are well known,[1] the objective most frequently cited by members of California irrigation districts is the provision to them of irrigation water at least cost. What is the meaning of least-cost water? Least cost to whom, and least cost of what water?

Voluntary, individual contract, which is a basic condition of traditional cooperatives, is absent in the public water district. Membership is determined initially at the time the district boundaries are fixed by a majority of those voting at a formation election. Subsequent changes may be made in these boundaries, and thus the membership.

A particular pricing practice, or other aspect of district operations may be deemed unfair or inequitable by a member or group of members within a district. Being unable to disassociate themselves from the organization, these individuals may form factions, or dissension groups, internal to the district. Such factions have been experienced in many California irrigation districts with respect to irrigating and urban groups.[2] These internal factions frequently become sufficiently numerous and powerful, in terms of member voting blocs, that the administration of the district becomes unwieldy and difficult. This may result in the

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1/ See Frank Robotka, "A Theory of Cooperation," Journal of Farm Economics, vol. 29, no. 1, February, 1947, p. 94; and Stephen Enke, "Consumer Cooperatives and Economic Efficiency," American Economic Review, vol. 35, no. 1, April, 1956, p. 96.

2/ See Elias, op. cit., Chapter XV, "The Newspaper Fight for Irrigation," pp. 120-129.

replacement of an integrated, district-wide development program by smaller, localized units, organized and financed through individual improvement districts within the same irrigation district. The extent to which different pricing practices avoid or tend toward equity problems is thus an important internal evaluatory criterion.

The physical interrelationships among different sources of water in multiple-source districts frequently entail joint costs. When such interrelationships exist, district pricing decisions, although directly related to district water deliveries alone, may also affect the costs of obtaining water from all available sources. Under such circumstances, the effects of pricing practices upon the cost of water from the entire water system available to a district membership is the relevant relationship for evaluation. Water delivered by the district is only a part of this system.

Additional internal criteria pertain to the functions and administration of the district organization. The payment complex provides the main source of annual income to the district.[1] Its components must be established so that the district may meet outlays incurred through current activities and functions as well as the servicing and retirement of outstanding district debt. The adoption of a particular pricing method may be appraised with regard to its effect on the general solvency position of the district. This refers to the ability of the district to pay debts as well as to finance capital improvements. Pricing methods may influence this in two ways. First, it may affect the certainty that revenues will be adequate to meet these district outlays for a particular year or longer period of time, thus facilitating year-to-year administration. Secondly, the pricing practice adopted by a district over a period of time affects the marketability of district bonds and may influence the rate of interest they carry. The enhancement of bond salability stems from improvements in ability-to-pay status

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1/ Those districts that generate and sell electrical energy are a marked exception to this and are discussed in Chapter III above.

as well as type of legal recourse afforded bondholders in the event of default. These are not necessarily the same for both components of the payment complex. The effect of pricing behavior on district solvency is an additional internal criterion.

A fourth criterion for evaluation pertains to the status of a district's water rights. Under California law, both the extent and type of water use by members of a district may affect the tenure uncertainty[1] of these rights, principally in terms of their jeopardy to prescriptive capture.[2] Thus, the degree to which a particular pricing practice diminishes water right tenure uncertainty is relevant to the present analysis.

Social Criteria

Social criteria relate to public welfare. If appropriately defined, they enable a ranking of alternatives in order of their degree of compliance to one or a set of public welfare objectives. A frequently cited objective in this connection is the maximizing of community satisfaction, the specification of which entails traditional problems of identification and aggregation. Welfare is related to individual preferences. The identification of these preferences and the extent to which they are fulfilled by a particular set of economic circumstances becomes especially difficult when one considers a group of individuals.

1/ Tenure uncertainty refers to protection against variability over time of the quantity of water usable under the right. See S. V. Ciriacy-Wantrup, op. cit., p. 297.

2/ In addition to prescriptive loss, appropriative rights may lose priority by types of water use. Municipal-domestic and irrigation are afforded a use priority under California law (see State of California, California Water Code, Sections 106, 1254, 1257, 1460, and 1461). Although there is no legislative or judicial authority in California for enforced advancing of the priority of an appropriation for one beneficial purpose over that of a prior appropriation for another beneficial purpose, these priorities pertain for simultaneous applications to file. See Wells A. Hutchins, The California Law of Water Rights (Sacramento: State Printing Office, 1956), pp. 105-108 and 174.

For a single individual, money is usually accepted as a numeraire, indicating certain levels of preferences attained. Hence, it can be said that the rational individual will select the alternative of action that will yield him the maximum income net of the costs entailed in receiving it. When we move from the individual, however, to the collectivity of individuals, the problem of aggregating over individuals becomes immediately apparent. The drawbacks of simple linear aggregation in such circumstances has been noted.1/

In addition to problems of aggregation, the difficulties of comprehending all the extramarket ramifications of different allocations of a given set of resources in a given community have been the basis of considerable speculation by many economists.2/ A criterion of allocative efficiency in these terms offer insurmountable problems at the conceptual level.

On the empirical level, much attention has been directed toward the concept of aggregate income. For many purposes it may be taken as an approximation of welfare. This is evidently a partial approach to welfare measurement, but quantitative expression has been achieved at the national and state levels.

Alternatives to particular pricing methods may be evaluated in terms of whether they tend to increase or decrease state income. State income is selected rather than that of a more local unit because public policy authority for irrigation districts in California resides at the state level. A more localized

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1/ The difficulties here are twofold. First is the problem of summing and expressing highly differentiated sets of things (factors of production or products). It is frequently held that this is avoided by using a price denominator, which is comparable for all such factors or products. Secondly, is the problem of interdependencies in utilities which renders linear aggregations invalid. See R. D. G. Allen, "Economic Theory of Index Numbers," Economica, New Series, vol. 16, no. 3, August, 1949, p. 197. The difficulties in the necessary assumptions about preference comparability over both space and time is discussed by R. Frisch, "Some Basic Principles of Living Measurements," Econometrica, vol. 22, no. 4, October, 1954.

2/ See Frank Knight, "The Limitation of Scientific Methods in Economics," The Ethics of Competition and Other Essays (New York: Harper & Brothers, 1935), pp. 105-148.

definition, while relevant to issues of repayment capacity, etc., may respond to a particular pricing alternative in a direction opposite to that of state income.[1] National income, on the other hand, is too broad a context, as public water districts are political subdivisions of the state.

The main impact of district pricing methods on state income is the extent to which such pricing facilitates or obstructs the adjustment of district-irrigated agriculture to secular economic factors throughout the state. Adjustment possibilities are affected by a district in two main ways. The physical structures involved in a district's distribution system may render the water input more divisible as a factor of production; or the costs associated with using that water are sensitive to the quantity used, which in essence, makes members more sensitive to the needs for adjustment. Primary focus is on the second influence upon adjustment possibilities.

It must be emphasized, however, that increasing individual economic sensitivity to production alternatives is not an unquestioned blessing. Analysis of agricultural price-output cycles, as the corn-hog cycle, has shown the adverse consequences overadjustment may incur--explosive price oscillations and instability in associated lines of production.

There is no single answer to how much adjustment is beneficial. This will vary under particular circumstances. With respect to the irrigation district, however, it reasonably can be assumed that the dangers of overadjustment, manifest in community instability and the consequent increase in individual uncertainty, are acknowledged by the community as represented in the district electorate. If such reliance may be placed on the diversity of interest and occupation of district voters, an evaluatory criterion may be specified in terms of the extent to

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1/ Economic variables that are net increments to local areas are frequently transfer items when considered from the standpoint of the state. A local land boom of temporary duration resulting from speculative district policies may be a liability to neighboring communities and the state.

which particular pricing alternatives facilitate the adjustment of district agriculture to secular economic forces.

An Evaluation of the Lower Tule River Irrigation District Program

As discussed in the previous chapter, the Lower Tule River Irrigation District has adopted a particular payment complex to implement a program of ground water management. The water toll component has been established in order to render district deliveries the prime water supply to members. As both the average variable cost and marginal cost for district water under this pricing arrangement are below those for pumping ground water under present depths to water, the sale of all available district water is assured so long as a demand for irrigation water exists.

Should there be excess water in a particular year, the district has announced a policy of purchase for artificial ground water recharge. Thus, the possibilities of prescriptive loss of the district's appropriative rights or contract renegotiations on the basis of insufficient use diligence is avoided.

The evaluation of the district's program in terms of least-cost water and equity criteria requires considerably more analysis. The district's involvement in water management activities concerns the future and the cost of water over time. Under average precipitation conditions, the surface water supply of the Lower Tule River Irrigation District derived from the Tule River and the district's contract with the Bureau of Reclamation will equal approximately 230,000 acre-feet.[1] Annual use of water within the boundaries of the district for agricultural use and for export has been estimated as 210,000 acre-feet.[2] Thus, during the average year, the amount of water used within the district is available from surface water sources.

Class 2 water from the Friant-Kern Canal, however, is subject to fluctuation. The quantity delivered in any one year to a district served will depend upon the

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1/ U. S. Bureau of Reclamation, Lower Tule River Irrigation District . . .
2/ Alexander, op. cit.

releases of water at Friant Dam and the timing and quantities of water delivered to other organizations served by the canal. During years in which no Class 2 water is available, the surface water will be approximately 171,000 acre-feet short of the average district water use. The lower the depth to ground water during such years, the less will be the total variable cost of pumping the deficit. The district has announced a surface water prorating policy for such water-deficit years which would effectively deliver surface water only to subarea 1.[1/] Assuming the pumping of 171,000 acre-feet of ground water within subareas 2, 3, and 4 in quantities proportional to their total acreage, variable cost conditions given in Tables 16 and 17 would prevail for pumping the deficit quantity from different depths to ground water.

Reduction in the total cost of pumping the deficit 171,000 acre-feet at a 30-foot depth to water is estimated to be $211,000 using present equipment and $440,100 if new equipment is used. This reduction may be considered as a gross, undiscounted saving to the district as a result of the ground water table rejuvenation program for a year in which no Class 2 [2/] water is available to the district.

The cost of the program to the district entails both monetary and equity dimensions. The district, being under contract, faces annual total outlays determined in part by deliveries from the Friant-Kern Canal. These charges are unavoidable. The opportunity to purchase additional water is limited during deficit years due to the prorating system of delivery used by the Bureau of Reclamation. As the district anticipates the development of extensive recharge facilities, it is expected to purchase water from other organizations situated along the Friant-Kern Canal when possible. So long as this additional purchased water is used for recharge activities, its total cost becomes a cost of the ground water

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1/ Ibid., pp. 32-33.

2/ See page 99.

TABLE 16

Cost of Pumping Ground Water During Water Deficit Years in the Lower Tule River Irrigation District With Existing Equipment Under Different Depths to Water by Subareas

Subarea	Pumping cost per acre-foot[a]			Total ground water pumped	Total pumping cost		
	Present depth to water[b]	Forty foot depth to water[c]	Thirty foot depth to water[d]		Present depth to water	Forty foot depth to water	Thirty foot depth to water
	dollars			acre-feet	thousands of dollars		
1	4.78	3.85	3.35	0	0	0	0
2	3.42	2.61	2.50	71,820	245.6	187.5	172.4
3	3.57	2.68	2.47	47,367	169.1	126.9	117.0
4	5.23	3.94	3.57	51,642	270.1	203.5	184.4
Total for district					684.8	517.9	473.8
Difference in district total cost from present depth to water						166.8	211.0

(Continued on next page.)

Table 16 continued.

a/ Calculations were made according to the following formula: Kilowatt hours required to lift one acre-foot = $(1.024)\frac{H}{E_o}$ where: H = head, or total lift, in feet and E_o = over-all efficiency of pump and motor. See Arthur Shultis and L. J. Booher, Estimating Electric Power Cost for Pumping Irrigation Water (Berkeley: University of California, Agricultural Extension Service, 1958) (Farm Management Facts for reference series) mimeographed. Lubrication costs equaling 1 per cent of the sum of service charge and power cost, and repair cost of 23 cents an acre-foot were added to power and stand-by charges. See Douglas D. Caton, Trimble R. Hedges; and W. Neill Schaller, Farm Adjustments and Earnings Under 1955 Cotton Acreage Allotments, San Joaquin Valley, Eastside Cotton Farms, 1953-1955, University of California, Giannini Foundation Mimeographed Report No. 202 (Berkeley, May, 1958), pp. 41 and 36.

b/ It is assumed that the mean E_o of 0.54, found from an investigation in 1954 involving 131 pumping plants in the Lower Tule River Irrigation District, pertain to the entire district. See U. S. Bureau of Reclamation, Lower Tule River Irrigation District, Water Supply (Fresno: Fresno Operations Office, February, 1955), p. 20.

c/ It is assumed that the E_o of 0.54 under present depths to water will be reduced to 0.49 with the decrease in depth to water. See Jacuzzi Brothers Inc., Jacuzzi Turbine Pumps (Richmond, California company published data on turbine pump efficiency curves).

d/ Ground water pumped during a water deficit year is assumed to total 171,000 acre-feet, and this total is prorated to areas 2, 3, and 4 according to their gross acreage.

TABLE 17

Cost of Pumping Ground Water During Water Deficit Years in the Lower Tule River Irrigation District With New Equipment Under Different Depths to Water by Subareas

Subarea	Pumping cost acre-feet[a]		Total ground water pumped	Total pumping cost	
	Forty foot depth to water[b]	Thirty foot depth to water[b]		Forty foot depth to water	Thirty foot depth to water
	dollars		acre-feet	thousands of dollars	
1	1.71	1.47	0	0	0
2	1.50	1.38	17,820	107.7	99.1
3	1.53	1.34	43,367	72.5	63.5
4	1.68	1.59	51,642	86.8	82.1
Total for district				267.0	244.7
Difference in district total cost from present depth to water[d]				417.8	440.1

(Continued on next page.)

Table 17 continued.

a/ Calculations were made according to the following formula: Killowatt hours required to lift one acre-foot = $(1.024) \frac{H}{E_o}$, where: H = head, or total lift, in feet and E_o = over-all efficiency of pump and motor. See Arthur Shultis and L. J. Booher, Estimating Electric Power Cost for Pumping Irrigation Water (Berkeley: University of California, Agricultural Extension Service, 1958) (Farm Management Facts for reference series). Mimeographed. Lubrication costs equaling 1 per cent of the sum of service charge and power cost, and repair cost of 23 cents an acre-foot were added to power and stand-by charges. (See Douglas D. Caton, Trimble R. Hedges, and W. Neill Schaller, Farm Adjustments and Earnings Under 1955 Cotton Acreage Allotments, San Joaquin Valley, Eastside Cotton Farms, 1953-1955, University of California, Giannini Foundation Mimeographed Report No. 202 (Berkeley, May, 1958), pp. 41 and 36.

b/ This assumes and E_o of 0.70 on new equipment, selected specifically for the new depth to water conditions. An E_o of from 0.74 to 0.78 appears average for 1,100 RPM Jacuzzi turbine equipment. See Jacuzzi Brothers Inc., Jacuzzi Turbine Pumps (Richmond, California company published data on turbine pump efficiency curves).

c/ Ground water pumped during a water deficit year is assumed to total 171,000 acre-feet, and this total is prorated to areas 2, 3, and 4 according to their gross acreage.

d/ Difference is calculated from district total assuming the use of existing equipment and present depth to water.

rejuvenation program, as the district's own quota from the canal is, on the average, adequate only to supply irrigation uses within its boundaries. The district will obtain receipts adequate to pay for this additional water by additions to the district assessment, as the toll of $2.20 has been administratively fixed.

The district incurs a total annual cost for its water quota and its ground water rejuvenation program, which is repaid by members through the payment complex. However, members also may bear an additional cost associated with pumping ground water. Presumably, they will not pump during the average delivery year as the contract supply is adequate to meet annual irrigation needs under present ground water conditions; and both the marginal and average variable cost of obtaining ground water exceeds $2.20. Indeed, as the established water toll is approximately equal to the average acre-foot cost of contract water to the district, the present pricing policy appears to assure a least-cost total water supply to district members during average delivery years under present ground water levels.1/

During years of less-than-average water delivery or underground water conditions such that the average variable cost of pumping is less than $2.20, additional pumping cost will be borne by district members. During water-short

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1/ The following cost conditions prevail under current contract conditions:

Maximum entitlement:

61,200	acre-feet Class 1 at $3.50 per acre-foot	$214,200
238,000	acre-feet Class 2 at $1.50 per acre-foot	357,000
299,200		$571,200

Average acre-foot cost: $1.91.

Average delivery:

61,200	acre feet Class 1 at $3.50 per acre-foot	$214,000
119,000	acre-feet Class 2 at $1.50 per acre-foot	178,500
180,200		$392,500

Average acre-foot cost: $2.18.

years, the average acre-foot cost of contract water to the district will be greater than $2.20, as Class I water will bear a higher proportion to the total water deliveries. Under these circumstances, individuals whose average pumping costs are between $2.20 and the average cost to the district for contract water in the particular year would desire to pump if the district secured receipts for contract water from the water toll alone. Indeed, that these individuals in fact do pump is a requisite to a least-cost total water supply for the district as a whole in that particular year. Thus, the $2.20 water toll, while adequate during average delivery years, does not assure a least-cost total water supply to the entire district during years in which less than average delivery is made.

Moreover, as the ground water level within the district builds up, it eventually will result in average pumping costs less than $2.20, in which case individuals facing these reduced costs presumably will choose to pump ground water. If they do, this additional cost is added to that for contract water. Hence, under contract conditions that firmly commit the district to paying for its quota, the water toll would have to be altered annually as the ground water conditions change so that it would be continually below the average pumping cost to assure a least-total water supply cost to the entire district.

Annual costs are incurred both by acquiring surface water for purposes of ground water recharge and the actual spreading operation. The resulting benefit realized by the district occurs at a different point in time. To economically evaluate such a program, it is necessary to know the size of the costs and returns, or savings, and the points in time at which they occur. In the case of the Lower Tule River Irrigation District, this will depend upon the frequency of water deficit years and the response of the ground water table beneath the district to the recharge activities. Precise information is not available for either of these two relationships. The frequency of water deficit years depends upon both meteorological phenomena and the future delivery schedule to be made from the Friant-Kern Canal. The latter of these will depend upon the outcome of contracts under

negotiation and renegotiation between the Bureau of Reclamation and organizations served by the canal. Data on the second depends upon the physical conditions of the ground water basin and upon the extent of future withdrawals of ground water by nondistrict areas overlying the common ground water basin.

Although empirical evaluation of the particular recharge program of the Lower Tule River Irrigation District is not possible, it should be noted that water-spreading practices have been adopted at an increasing rate by public water districts throughout the state.[1/]

The Payment Complex

In addition to appraising the particular pricing practice of a given irrigation district, the components of the payment complex individually may be evaluated in terms of the criteria developed above.

The District Assessment.--In terms of internal criteria, the most obvious advantages of this component of the payment complex pertain to its impact upon the financial solvency of the district and the relative ease of administration that an assessment entails.[2/] The assessed unimproved property value base on which an assessment rate is levied annually is relatively stable. Changes in this value base are determined by the board of directors of the district, as is the total rate of levy. The product of these two factors becomes an unavoidable binding obligation on the district membership. Receipts to the district from this source thus can be predetermined by the board, and payment is enforced by tax foreclosure.

The predeterminable nature of the assessment revenues becomes a distinct advantage to the district in light of the high portion of the total district

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1/ Smith, op. cit., p. 260, footnote 9. Also, Banks, Richter, Coe, McPharland, and Krestinger, Artificial Recharge in California (Paper presented to Hydraulic Division, American Association of Civil Engineers, Austin, Texas, September 8, 1954). Mimeographed.

2/ See M. F. Brewer, "Repayment and Produce Pricing in Small Watershed Development," Water Resources and Economic Development of the West: Small Watershed Development, Rehabilitation and Reorganization of Irrigation Projects, Report No. 6, Conference Proceedings of the Committee on the Economics of Water Resources Development (Berkeley, 1958), pp. 45-60.

outlay that is relatively fixed from year to year. Bonded debt, although not the largest item of district outlay, is fixed at the time the bonds are issued. In addition to this, much of the operation, maintenance, and administrative expenses of districts are not significantly related to the quantity of water sold by a district.[1] These services are required annually to prevent canal system deterioration regardless of the amount of water carried in a particular year. As these costs to the district remain relatively fixed[2] from year to year, a revenue source that is similarly fixed holds obvious administrative advantages.[3]

From the standpoint of the other internal criteria developed, the assessment appears a mixed blessing. In those districts that contain assessed but unirrigated lands, its use may lead to equity problems between irrigating and non-irrigating members. Even when relatively full irrigation development has taken place within a district, equity problems may also be entailed due to ground water pumping cost differentials.[4]

The use of the assessment holds certain advantages from the standpoint of increasing water rights security. Use diligence[5] increases with the number of

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1/ Of ten irrigation districts contacted in the San Joaquin Valley, the maintenance and supervision of the distribution system constituted the largest component of the operation and maintenance accounts for 1956-57.

2/ These costs may be temporarily shifted over time; however, maintenance standard requirements that are established for many districts--as, for example, those contracting for water supplies or federal construction of distribution systems and districts receiving federal loans--substantially limit the extent to which such costs may be shifted.

3/ A parallel advantage of the assessment has been noted in its influence in strengthening the market for bonds of individual districts. In many instances, district assessment is a basic requisite to the existence of such a market at all. Interview with Mr. John Peaslee, California Districts Securities Commission.

4/ For example, the use of the assessment--a fixed cost--may "force" a member to use a district source even though he could pump the same quantity of water for less total cost. Were no assessment used, the higher total cost of the district supply could, and presumably would, be avoided by using no water from this source.

5/ Use diligence refers to the commitment of water to a beneficial use. In the absence of such diligence, certain water rights may be lost by prescriptive capture.

acres within a district irrigated from district supply. A payment complex with a relatively high assessment component stimulates the expansion of irrigated acreage within the district. Indeed, this advantage of the assessment may well override other considerations during the early stages of district development. Where relatively full irrigation development has taken place within a district, the imposition of a high assessment may continue to stimulate the use of district water as a prime water source for irrigation--again, a positive attribute from the standpoint of water right fortification.

We have seen, however, that the use of the district assessment permits a reduction in the water toll component of the payment complex and, thus, may tend to force the use of district water on land which would otherwise use water from other sources. This has been exemplified by the Lower Tule River Irrigation District. If a higher net return from irrigation is possible within areas adjacent to the district, and if such areas can obtain surplus water from the district either by water right forefeiture or purchase, the adoption of high assessments will reduce the real product of the region.

The extent to which the possibilities of such inefficiencies exist depends upon the area within which water transfer is feasible, the extent to which "better land"[1] of this area is within the district boundaries, and the size of the district's water supply. We may consider two groups of districts in this respect--older districts with substantial water rights and newer districts receiving all or a portion of its water supply under contract.

The boundaries of older irrigation districts tend to include the better quality lands in the region potentially serviceable from the distribution facilities contemplated at the time of district formation. This fact, in combination

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1/ This term relates to the relative quality of all site conditions, including topography, ground water conditions, soil type--in short, all elements that affect the net farm returns from irrigation.

[illegible]

with the limited opportunity for surface water exchange with other lands in the vicinity of the district, tends to mitigate the opportunity for inefficiency by the displacement of higher quality land by that lower quality.

Those districts contracting with the Central Valley Project, on the other hand, do have a substantially larger area in which water exchange is feasible. Furthermore, many of these districts, being relatively new, do not necessarily contain better quality land, as their boundaries frequently are determined by conditions other than susceptibility to and potential benefit from irrigation.[1/] The contracts awarded by the Bureau of Reclamation are based upon field studies of each district that consider specifically the crop pattern, soils, and alternative sources of water available for use within the district. The attempt is made to award contracts for water only insofar as that water will be beneficially used in irrigated cultivation within the district. Thus, the possibility for inefficiencies stemming from the use of the district assessment is tempered. In the first group of districts, this is by the inclusion of "better" land within the district boundaries and the limited water exchange opportunities and in the latter group by attempts to award contracts so as to avoid such inefficiencies.

The assessment has a dual influence on the rate of conversion of district land from dry to irrigated cultivation. On the one hand, the cost-spreading impact of the assessment increases the net returns to farmers making the transition[2/] and, thus, permits a more rapid transition of production practices. On the other hand, the assessment simultaneously penalizes unirrigated district land.

1/ The Lower Tule River Irrigation District (formed in 1950), for example, has the same boundaries as those of an earlier organizational proposal (1943) for the area to form a water conservation district providing principally flood protection benefits.

2/ The extent to which a shift in cost incidence accompanies the assessment depends upon the proportion of total assessed property value comprising nonirrigated district land. The cost-reducing impact thus is most pronounced during the early stages of district irrigation development.

Once development is relatively complete within a district, however, the total payment to an individual district member remains approximately stable. Under these conditions, the fixed-cost aspect of the assessment may constitute a limitation on the flexibility of the irrigated farm unit. This is particularly true under conditions of secular economic downturn as evidenced by the large areas acquired by districts under tax deed during the mid-1930's. Thus, the economic advantages of the assessment during the early stage of district development do not necessarily continue under conditions of relatively full development.

Irrigation District Assessments and the Subsidy Question

Discussion of assessment by public water districts frequently conclude that its adoption entails a form of subsidization of those district members who irrigate by nonirrigating members.

In viewing this charge, a distinction needs to be made between a public grant of privilege to private persons for which they render no equivalent service to society and payments to individuals for services rendered. If the recipients render services relatively commensurate with the payments made to them, no particular problem is involved. The same is true in instances where an irrigation district of the government, on behalf of its respective constituency, makes an outlay or investment for the general welfare. Individuals may benefit differently, each according to his interests and capacity, but all enjoy the same opportunity. Under such circumstances, it is only when certain strategically situated individuals are in a position to derive some special gain not open to others that a problem arises. An equalization of economic advantages by appropriate charges against these special beneficiaries may eliminate this problem.

It has been maintained that when members who do not use the water their districts supply are assessed, the effective cost of using water artificially is reduced and may result in a misallocation of the resource. If users do not pay in full the costs entailed in making the resource available for use, production is

possible which does not return a value equal to this cost, and real income is decreased accordingly.

The basic assumption of this line of reasoning is that some of those upon whom the assessment is incident in fact are not water users and, hence, are forced to make expenditures through the district assessment process in return for which they do not receive commensurate benefits. The argument identifies district benefits with physical water deliveries.

The organization of a public water district may provide other benefits to areas near the region in which district water physically is used. These may or may not be limited to the boundaries of the district.

To illustrate this, two frequently cited indirect benefits--the establishment of a more desirable social organization and the increase in the stability of local agricultural economies[1] are considered. The incidence of such benefits will be determined largely by the interrelationships within the economic system to which they apply. Their incidence will depend upon transportation facilities, political organization of the community, etc., and is not coincident geographically with the boundary of an irrigation district.

On the other hand, an additional family of indirect benefits relates to the possibility of receiving a future water supply from the district, although such a benefiting area might not presently be under irrigation. The area of incidence of this type of indirect benefit is clearly defined by the boundary of the irrigation district.

The most apparent reason for property value enhancement is that a district member, although not at present receiving a supply of district water, may

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1/ U. S. Bureau of Agricultural Economics, U. S. Department of Agriculture, The Effects of the Central Valley Project on the Agricultural and Industrial Economy and on the Social Character of California (Berkeley, 1945). (A report on Problem No. 24, Central Valley Studies.) Mimeographed.

[illegible]

[illegible]

[illegible]

anticipate a future district supply at a cost less than a similar supply from alternative sources.[1] Enhancement of property value may occur purely by virtue of the physically larger potential water supply, rendering district land both more flexible and more adaptable than otherwise comparable nondistrict land.[2] Comparison between the agricultural value[3] of district and nondistrict land would be expected to reflect these differences. As is brought out below, the sale price of land is not necessarily identical with the agricultural value, but changes in the latter would be expected to be directionally reflected in the former.[4]

1/ This may not be a lower unit cost for every quantity of output--that is, district supply may be supplemental to a prime source, but the total supply of water available from the two sources is lower than a similar quantity supply from the prime source alone.

2/ Such land has greater flexibility in light of changing conditions of the ground water table or other changes that might affect the cost of ground water and also greater adaptability to different uses requiring or utilizing varying amounts of water.

3/ The value concept is identified with the present value of the future income flow to be derived from such land.

4/ This hypothesis appears to be supported by observations of land sales data from the field offices of the National Farm Loan Association in the San Joaquin Valley. Although data are extremely limited, the following indicate differences in average sales price per acre of unimproved farm land within and outside of the Fresno and Turlock Irrigation districts.

Average Sales Price Per Acre of Land Exclusive of Buildings[a] in Constant Dollars (1940 = 100)[b]

Soil type: Fresno silty loam [c]	
Crop type: alfalfa[d]	
Inside Fresno Irrigation District (n = 11)	$179.43
Outside Fresno Irrigation District[e] (n = 3)	$117.99
Soil type: silty loam[c]	
Crop type: alfalfa[d]	
Inside Turlock Irrigation District (n = 13)	$188.66
Outside Turlock Irrigation District[e] (n = 2)	$ 80.19

a/ Appraiser's evaluation of buildings deducted from recorded sales price of entire farm property.
b/ Index of United States farm land value (exclusive of improvements) used to deflate recorded sales price.
c/ Observations made on only similar soil types.
d/ Predominant crop type for the three years prior to sale.
e/ Within the same township or the one adjoining district boundary.

Source: U. S. Department of Agriculture, Agricultural Research Service, Current Developments in the Farm Real Estate Market (Washington, July, 1956), pp. 43-48. (CD-44.)

An attempt to value such property enhancement has been made in the Terra Bella Irrigation District. During the depression, the district acquired substantial acreage of lands under tax deed which it auctioned off in 1956. In addition to the auction price, the district stipulated an acre charge of $150 for reinstatement to district "water rights."[1]

Similar types of value enhancement occur in irrigation districts that engage in other activities which materially affect the conditions of ground water basins as, for example, the practice of water spreading. District boundaries usually do not conform to such underground water bodies. The basic boundary criterion is the availability of the land surface to existing or contemplated surface water distribution systems. In the event that a district does not overlie the perimeter of the ground water area benefited by district water spreading activities, effort may be made to include or organize other areas of benefit not now in the district.[2]

The economic benefit of the district form of organization for a particular piece of land is reflected in the sales price of the land so enhanced.[3] If no

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1/ Leeds, Hill, and Jewett, Master Plan of Development of Terra Bella Irrigation District, Tulare County, California, pp. 67-88. Mimeographed.

2/ Such a situation exists with respect to the area adjoining and south of the Lower Tule River Irrigation District. Both areas overlie a common underground water basin. The area not within the district has no irrigation water sources other than ground water, and depth to water increases sharply south of the district boundaries. Initial steps have been taken to form a new irrigation district about this area largely as a result of urging from the Lower Tule River Irrigation District, which has provided considerable technical assistance during the preliminary phases of organization.

3/ While comparisons of such data are useful in revealing differences and directions of change, the variation within individual sets of data and between data from different sources precludes their use as a precise measurement of such benefits.

Frequently, the market sales price of land is strongly influenced by anticipated changes in the type of use of a particular piece of land. The presence of speculative land markets, particularly with respect to individual parcels of land in the vicinity of urban centers, has long been recognized. This is distinct from the enhanced value of land for purposes of agricultural production resulting from the availability of district water for use on particular lands. The distinction between enhanced value of land due to the capitalization of anticipated future earnings and increase in speculative value needs to be emphasized. Speculative land price can be said to be a function the probability distribution of the expected value of future earnings if a particular event occurs and the probability of that event actually occurring. In distinction to this, the capitalization of anticipated future earnings is a function of expected future earnings of that land.

assessment is levied upon such land, present owners may capture the enhanced value at the time the land is sold subject to capital gain tax. The increased sales value, attributable to being within the district, will constitute additional cost elements to land as a factor of production to the subsequent owners, tending toward the adoption of land uses such that the annual average value productivity of the enhanced land equals or exceeds the amortized cost of the land at the time of acquisition.

So long as the irrigation district does not levy an assessment upon the non-water-using individual whose land has received such an enchanced value, he will not necessarily be induced to place that land in a higher line of economic use. In fact, the speculative motive frequently involves the postponement of this transition in use and may tend toward the maintenance of such land in less productive uses.[1/] On the other hand, the imposition of a district assessment upon such an area will, in itself, constitute an increase in cost of land proprietorship, regardless of to what use the land may be put. If this assessment is, in fact, so calculated that it just captures the enhanced value of that land, there will be a tendency for such land to be placed into an economically "higher" use.

Evaluation of an "early" transition in land use as opposed to a postponed transition entails a comparison of future net returns streams over time, aggregated to a common point in time. Of central concern is the question of whether or not land productivity for irrigated agriculture is characterized by a definite life. Its answer requires examination of soil structures and their changes over time and in different uses. In California, it is assumed that the productivity of irrigated land at a point in the future, such as 30 years from the present, will not be reduced by having been brought into production at an earlier as

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1/ If an increase in the net worth of land is anticipated as the result of a change in the type of land use (for example, domestic subdivision), the initial investment required to convert to irrigated cultivation may not be made. This could result from an anticipation of selling before such outlays could be amortized or because of capital limitations.

opposed to a later point in time.[1] Under such circumstances, the earlier land use transition appears desirable in terms of increasing real income.[2] In addition to the difference in net returns per acre of irrigated over dry-farmed land, the assessment stimulus to irrigation may result in the early accrual of indirect or secondary benefits.

Two categories of secondary benefits frequently have been considered in the literature--those benefits stemming from and those induced by development works. These categories have been defined[3] with the former representing secondary economic impacts accruing in connection with the processing of the immediate products produced as a result of development works. Benefits alluded to as "induced by" accrue because expenditures by the producers of the immediate products stimulate other economic activities. If the imposition of a district assessment promotes the realization of indirect benefits, it is relevant for pricing policy to analyze the incidence of such benefits within public water districts and, in terms of this, to appraise the equity of assessments.

Considering first benefits resulting from processing and marketing of the agricultural products of irrigation districts, the situs of such activity probably will be an urban center or town situated on a railroad or highway and would pertain to land within the boundary of the district as well as to proximate areas outside the district boundaries.

Activities induced by irrigated agricultural production also would tend to be concentrated urban areas. Benefits from such service activities accrue to

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1/ This abstracts from both gradually reduced productivity over time as well as from increasing productivity--possibly due to the "flushing" effect of early years of irrigation on soils of high alkali content.

2/ This, of course, would not obtain if prices were distorted, either by government fixing or monopolistic-monopsonistic elements in the market structure, to the extent that the real (intrinsic) value of inputs were less than that of output.

3/ Subcommittee on Benefits and Costs, Proposed Practices for Economic Analysis of River Basin Projects (Washington: Government Printing Office, May, 1950), pp. 8-9. (Report to the Federal Inter-Agency River Basin Committee.)

areas within as well as outside the district boundary. The principal determinate of their incidence is transportation costs, which increases radially from the urban focii of such service industries.[1/]

The district assessment thus appears an economically justified component of the district pricing mechanism. It is to be noted, however, the frequent claims that the assessment is a method of taxing land into greater economic production usually assume implicitly that the costs of other factors and prices received for products grown remain the same as prior to such a transfer. If rapid, widespread transfer from dry land to irrigated cultivation occurs, factor costs will tend to increase and product prices decrease, at least temporarily.

The Water Toll

The advantages of a predetermined and stable district income that were associated with the district assessment do not necessarily obtain in the case of the water toll. Where alternative sources of water are available to district members, a relatively high water toll component of the payment complex may result in a shift of the prime water source from district supply to ground water, impairing the solvency position of a district. Use of the water toll, however, places district charges upon water-using individuals and, hence, frequently may be used to deter the development of factions internal to the district due to the inequity possibilities of a relatively high district assessment.

With respect to the district's water rights, a relatively low toll increases the probability that all members will use the district supply fully. A relatively high toll, on the other hand, may result in the accrual of annual surplus waters to the district which may either be used directly by the district in recharge activities or exported. It is of interest to note that the increasing use of such

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1/ It is of interest that assessment practices in the South San Joaquin Irrigation District during the period 1925-1930 entailed a valuation procedure that reduced the valuation for district assessment purposes radially from urban focii. See Adams, Irrigation Districts . . . 1929, p. 173.

surplus water for purposes of artificial recharge is acknowledged as a beneficial use under California water law. Districts engaging in this use of annual excess supply will not necessarily thereby experience legal jeopardy of their water rights.

The base upon which the toll is computed is of social consequence. If administered on an area basis, as in several districts in the Sacramento Valley, there is a tendency to use the entire quota of district water available on each acre of land irrigated from this source. No incentive for careful water use is present, and inefficiencies in application may be experienced.[1/]

Area based water tolls also may result in equity problems. Different acre-foot charges for different crops will result unless the ratio of tolls for two crops equals the ratio of the actual district water applied on these crops. Use of the area base entails less administrative and supervisory attention in district accounting procedures; however, such differences in acre-foot charges are obscure and more difficult to assess than with a volume based toll.

Suggested Procedures

Considerable attention has been devoted to various possible pricing arrangements to be used for irrigation water. Implicit in criticisms of public water district pricing practices accompanying this discussion, is the concept of an economically preferable set of pricing rules. Considering both components of the payment complex, three basic alternative approaches present themselves. These are as follows:

1. The determination of an assessment receipts target for a particular year, with the water toll being set so that the residual between the total budgeted annual outlay and the assessment target is secured in the form of water sales receipts.

2. Fixing the water toll either in structure, according to economic criteria, or to a total sales receipts target,

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1/ This assumes that the last units applied hold relatively low productivity. So long as there is any positive productivity associated, irrigating members will use their entitlement, as their marginal cost of district supply is zero.

with the difference necessary to meet budgeted outlays obtained from the collection of district assessments.

3. Establishing a ratio between sales and assessment receipts, and letting the absolute magnitude of each be governed by the budgeted, annual outlays of the district.

Most arguments have focused upon the second approach and have been concerned with developing economic criteria for determining the structure of an optimal water toll. The failure to recognize explicitly the assessment has forced most discussions to an entirely theorectical level with little operational relevance.

Marginal cost pricing has been one of the most frequently argued positions in this regard. It is contended that product pricing by a producing firm at an amount equal to the marginal cost of producing a given level of firm aggregate output simultaneously results in maximum firm profits and, in the long run, an optimal allocation of the resources or products so priced.

Both formal and operational drawbacks to the marginal cost pricing rule may be cited. The most frequent theoretical objection focuses upon situations with average cost functions varying with output. If it decreases over the relevant range of output, the marginal cost function lies below the average. The use of marginal cost pricing for output within this relevant range clearly results in operating deficits. An increasing average cost function, on the other hand, has associated with it a marginal cost that also increases and lies about it. Under these circumstances, excess returns are secured by following the marginal cost pricing rule for which there may be no nonarbitrary method of redistribution by a public agency.

Operational objections further challenge the relevancy of the marginal cost for public water district pricing purposes. In applying marginal cost pricing, it is necessary to have specified or assumed basic production and cost functions. Specifically, it is further required that the total cost function may be meaningfully differentiated with respect to the quantity produced, so that the key

function of the analysis--the marginal cost function--can be defined. Although one may maintain the existence of a marginal cost, how is it to be measured? Even reducing categories of district outlay to operation and maintenance and administration, the former is variable only within narrow limits.

Average cost pricing also has been recommended. Sometimes this has been confused with the frequently used merchandising average-cost-plus procedure.[1/] This is not considered in the present discussion. Average-cost pricing implies that each unit of the product produced must be able to pull its own weight. It argues for a price so that all money outlays that could have been avoided if a product had not been produced are recovered in the price of the product.

This rule may be attacked on the basis that some of the factors included in average-cost pricing are not currently opportunity costs but, rather, fixed costs and that their inclusion prevents optimum welfare conditions. These conditions would say that additional consumpiton should be had at a price not greater than the additional costs necessarily incurred in providing for the consumption. The average-cost price rule would, therefore, curtail use before the optimum was reached.

The basic argument for average-cost pricing by public agencies centers on the fact that, under certain conditions, the marginal-cost price would either not

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1/ Average-cost-plus pricing refers to the use of a predetermined markup of the average cost. If such a markup is in the form of a coefficient rather than an added constant, and the average cost equals marginal cost at the particular level of output, average-cost-plus pricing may be identical with marginal-cost pricing.

For: Average variable cost (AVC) = marginal cost (MC) = price (P) times $(1 + \frac{1}{e})$, where e is the elasticity of demand for the product with respect to its price;

Then: $P\ (1 + \frac{1}{e}) = AVC$;

And: $P = (1 + e)\ AVC = MC$: $\frac{e}{1 + e}$ is the coefficient markup.

supply sufficient total returns or its adoption would result in a situation characterized by the securing of large quasi rents to the distributing agency. Average price, it is argued, would establish price at a point where total receipts are guaranteed to cover the total outlay for the water sold.

In distinction to marginal- and average cost pricing, several forms of discriminatory pricing have been proposed for water.[1] Such prices may be perfectly discriminatory, comparable to those of a pure monopolist, or they may be discreet and made up of several parts. The essence of perfect discrimination entails a different price charged for each unit of output sold, determined by the position of the average revenue function, or demand function, which presumably measures benefits received. Thus, in such an instance, the traditional demand function of economic theory becomes the district's marginal revenue function as it represents additions to total revenue resulting from additional water sales. An average revenue function will be above the marginal so long as the quantity demanded is not perfectly elastic with respect to price. The price and quantity combination determined by the intersection of the marginal revenue and the marginal-cost functions appear to fulfill the welfare criteria. The demand function, however, would reconstitute itself to the left of the initial position as water units were sold at the higher price, resulting in a final quantity exchanged which is less than that required for optimum welfare conditions.[2]

Aside from this technical objection and the obvious equity problems of differential pricing, discriminatory price proposals would require an ex ante

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1/ J. Margolis, "Welfare Criteria, Pricing, and Decentralization of a Public Service," Quarterly Journal of Economics, vol. LXXI, no. 3, August, 1957, pp. 448-463.

2/ The general problem of discriminatory pricing and the continual reconstitution of the demand function that would be entailed was raised by O. Morganstern, "Demand Theory Reconsidered," Quarterly Journal of Economics, vol. XLII, no. 2, February, 1948, pp. 165-201. For a recent application of this reasoning see R. L. Winestone and A. A. Wichmann, "A Re-Examination of Discriminatory Price Practices," Land Economics, vol. XXXIII, no. 2, May, 1957, pp. 149-153.

determination of the marginal revenue product of water in alternative district uses, raising substantial problems of administration.

The principal point of interest here is not in the technical nor administrative difficulties but rather in the fact that discriminatory pricing affects a redistribution of income. Once a pricing principle changes economic magnitude other than the conditions of choice, it becomes necessary to establish further policy criteria concerned with these other magnitudes in terms of which alternative proposals can be assessed. The principle behind discriminatory pricing--that is, capturing the consumer's surplus--logically may be relevant but the appropriate instrumentality for its achievement lies in methods of income redistribution other than water pricing.

Administrative and Economic Attributes of Irrigation District Pricing Practices

Any particular pricing arrangement holds attributes pertaining to what we have defined as sets of internal and social criteria. Frequently, these criteria are not consistent with respect to a given payment complex--either between these two sets or within the same one. What may be a desirable practice from the standpoint of reducing the tenure uncertainty of a district's water rights may, for example, tend toward an inefficient use of irrigation water by members or give rise to equity conflicts. Actual pricing behavior represents a compromise of all of these criteria.

The antethesis, or polarity, between these two sets of criteria is not stable over time nor does it exist in the same degree for different districts. Differences between the two increasingly have become evident as districts have approached what may be considered a "stage of maturity" with respect to internal irrigation development. For young districts with relatively little land under irrigation, the use of the assessment holds advantages from both district and social standpoints. The facilitation of the transfer from dry land to irrigated cultivation, the administrative desirability for a fixed source of receipts, and

the legal consolidation of the district's water rights tends to be advanced by the use of the assessment. Moreover, during this early stage, the developmental objective frequently is espoused by the entire district constituancy---urban and rural, irrigating and dry farming alike. Equity arguments arising within districts during this early phase of irrigation development generally have emphasized the inequity of a high water toll to the irrigating member rather than the cost incidence on nonirrigators caused by the use of assessments.[1] Because of frequent parallelism in the two sets of criteria during the early state of development, pricing practices can satisfy both types to a reasonably full extent.

The two sets of criteria diverge once relatively full irrigation development has occurred within the district, and the compromise manifest in actual pricing practices becomes more pronounced. The developmental transition is marked by changes in the functions of district management. For instance, once the development phase is passed, the large initial district outlays for distribution systems no longer obtain. Similarly, bonded district debt becomes less burdensome, and the degree and urgency of district solvency is not so pressing as during the earlier stage of development.[2]

Aside from changes in the objectives of district management, the transition alluded to holds implications for district members. The relatively high outlays required for converting to irrigated agriculture are no longer facing the majority of members. Moreover, the continued use of district assessments at the same level as that used during the developmental phase may be less justified economically. This is particularly true if the principal impact of secondary benefits has been capitalized into district land. Under these circumstances, the quid pro quo function of the assessment is not so clearly applicable.

1/ Elias, op. cit., p. 344.

2/ Important exceptions are those districts contracting with the Central Valley Project either for water purchase or for distribution facility construction. These contracts are of 40 years' duration and require annual payment for water delivered each year of a pro rata portion of the total expense of the facility construction.

Indeed, for most districts today, the criterion for efficient pricing practices largely may be predicated upon the extent to which the practices adopted render district production reflective of the external economy of California irrigated agriculture. Continuation of pre-full-development pricing practices, characterized by relatively high assessments and resulting in a low average variable and marginal cost for water may shield member irrigators against some of the impacts of this external economy. Thus, there may be a stickiness in the responsiveness of district agricultural production to the external economy.

Although future pricing practices are not expected to ignore the internal administrative interests in the district, it appears logical that the set of social economic criteria should constitute the dominant guide for future irrigation district water pricing practices.

VI. CONCLUSIONS

Flexibility and Standards for Pricing

The public water district in California long has been an effective institution in bringing and maintaining land under irrigation. It has been a viable organization in meeting a changing economic environment and a variety of physical problems in the past. Similar change may be expected in the future. The districts themselves have undergone a transition to comparatively full district irrigation development. In the past, the availability of irrigable land and water coupled with a strong market for irrigated agricultural products stimulated such development.

The payment complex has been instrumental in facilitating district adaption to past changing conditions. Its broad ramifications permit it to be used purposefully to achieve water management objectives and administrative and financial ends as well as relatively rapid irrigation development within district boundaries. This has resulted in considerable variety of pricing behavior. For example, pricing policy pursued in the Lower Tule River Irrigation District as a means for

implementing a program of water management probably will not be replicated in older districts characterized by ample water supplies secured through early appropriative rights.

In addition to pricing diversity among districts, most of them individually have changed their practices over time. This was exemplified by changes occurring in the size and composition of the payment complex during the mid-1930's, representing an adaption to the depressed agricultural market, capital shortage, and other attributes of the national depression. Had the 1930 average per-acre valuation been maintained, the rate of tax foreclosure would have been substantially higher, with the consequent social costs of production loss and resettlement. Pricing modification has also accompanied internal district changes. Increases in domestic water service have been paralleled by higher water tolls. Electrical generation and sale provide a method for underwriting irrigation system development and maintenance costs, and practices have been modified accordingly in generating districts. Water management programs have been implemented by introducing new prices representing departures from previous practice.

In light of the diversity of circumstances and wide variety of practice that has evolved, what can be said about establishing standards for future pricing? Certainly, the wide ramifications of the payment complex immediately argue against any uniquely prescribed price as being the "best" for all public water districts. On the other hand, the increasing demands on water throughout the state and the large investments contemplated in the California Water Plan call for safeguards against pricing practices that result in clearly inefficient water use--either by members or nonmembers to whom such water is exported.

Accepting the need for flexibility in future pricing, such safeguards must be limitational rather than formulative in character. Too frequently, policy standards have been initiated in terms of a prescription appropriate for a problem occurring at a particular point in time and space but inappropriate with future change. Although difficulties in application and enforcement frequently

make rigid requirements simpler to administer than flexible standards, the latter are clearly indicated for California irrigation districts.

Recommendations

The basic principle of payment by beneficiaries for the services or products they receive implies a gradual shift in incidence of district charges from total membership to those receiving primary benefits from the district activities. Secondary benefits arising in conjunction with irrigated agricultural development tend to diminish in magnitude over time, as such benefits are capitalized into land. The old rule of thumb of using district assessments to pay for the interest and principal payments of district bonds partially reflects this point of view. It would appear that the payment of general district administration expenditures in addition to outlays on the capital account could justifiably be made from assessment receipts.

Such a gradual phasing of cost incidence from all members to primary beneficiaries in a district is achieved under this rule-of-thumb dictum if the annual payments for interest and principal on district bonds decrease over time. The Central California Irrigation District has recently issued bonds under such repayment conditions. The more typical issues, however, require equal annual interest and redemption payments and would result in a single level of assessments for all members until the entire issue was redeemed. At that time, assessments normally would be reduced substantially to a level that would cover general administrative expenses of the district. A phasing effect could be produced for equal annual repayment issues by building up a reserve fund during the early part of the issue and a payout period during the latter.

Obviously the extent to which the adoption of this phasing principle would alter the cost incidence on district members will depend upon the ratio of numbers irrigating to nonirrigating members and the valuation of their respective property subject to district assessment. In a district comprised entirely of

irrigators as approximated by the Lower Tule River Irrigation District and assuming no discriminatory assessed valuation practices, no change in incidence would take place. The only result would be a shift from the fixed cost to the variable cost component of each member's annual payment to the district. The relevancy of this general principle is clearly more applicable to those districts with considerable nonirrigating members. Indiscriminate adoption would preclude the use of the payment complex as a water management tool as it is currently being used in the Lower Tule River Irrigation District.

Not all districts could adjust to such a procedure with equal ease. Irrigating members of certain districts may be faced with temporary periods of reduced ability-to-pay, accompanying the expansion of irrigated acreage. In districts contracting with the federal government for the construction of distribution facilities, arrangements for assessment receipts to meet annual repayments would have to be made. Moreover, many districts engage in several functions from each of which there may be different groups of primary beneficiaries. Under such circumstances, it is not clear that a reduction of assessments paralleling the redemption of outstanding district bond issues is economically justified. For the typical district not engaging in power generation or domestic service, however, such a transition in pricing appears warranted.

The Base for District Assessments

More specific recommendations for pricing practices may be cited, relating to the base employed by irrigation districts for both the water toll and assessments as well as to contract stipulations between public water wholesaling agencies and public water districts.

The base for irrigation district assessment remains, by law, the value of the unimproved property within district boundaries. The wide variety of methods whereby this property actually is valued has been mentioned. The transition from the use of value bases that reflect the secondary benefits of the district to

its members[1] to bases reflective of primary benefits to irrigated agriculture within the district has been noted. This transition has paralleled a declining importance of the secondary benefits as a district becomes relatively fully developed and is exemplified by the current shift to soil classification bases. Of the several types of soil classification available,[2] that of the Bureau of Reclamation is most widely used by irrigation districts.

Primary benefits received may be considered synonomous with the increase in net returns experienced by members as a result of the district organization and may be taken as the basis for efficient cost allocation among members. Of the soil classification systems presently available, none serve as indicators of the net returns from irrigated farming on a given piece of land. The system used by the Bureau of Reclamation involves six classes of land and reflects the physical output to be derived from irrigation. To reflect net returns, this physical product must be expressed in value terms and from it the production costs would have to be deducted. The soil classification system recently proposed by the California Department of Water Resources,[3] on the other hand, is primarily reflective of the costs entailed in bringing these lands under irrigated cultivation. Whereas the amortizement of these development costs are of

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1/ The old zone valuation of the South San Joaquin Irrigation District is a case in point. The common Practice of a flat sum valuation of all lands assessed also implies that the district benefits accrue equally to all members irrespective of their use of district water.

2/ Among the soil classification systems used in California are the following:

1. Great Soil Group Classification (U. S. Soil Survey).
2. Soil Classes I-VI (U. S. Soil Conservation Service).
3. Storie Classification (A weighted multiple of physical factor values).
4. The California Department of Water Resources Classification System.

3/ California Department of Water Resources, Northeastern Counties Investigation (Sacramento, December, 1957), Table 33, p. 183. (Bulletin No. 58.)

relevance to the net returns from irrigated cultivation on these lands, the system of classification does not itself indicate net returns.

The various interpretations of the full cash value instructions of the California Water Code have been mentioned. Although appearing initially cumbersome, the use of land market prices as an index for valuing district property would reflect the stream of expected future net returns to be derived therefrom and would be preferable to present methods of determining assessed valuation. Such a market price would require historical records as land speculation and unusual market conditions cause substantial year-to-year price fluctuations. Establishing records of land sales data by districts would, over a number of years, provide averages indicating price differences within the district. Relative value differences between land parcels rather than their absolute market price would determine the incidence of the resulting assessment.

The Base for the Water Toll

The two bases on which the water toll currently is established are either per area irrigated or per volume unit of water used. The former base is prevalent in irrigation districts situated in the Sacramento Valley and the northern portion of the state. Districts in the San Joaquin Valley and southern California use the volume base almost exclusively. The tendency to use excessive amounts of water under an area toll base has been noted. There is no inducement to curtail use unless quantitative restrictions accompany the use of this base for the water toll. These would have to differ with crop and soil type and would be extremely difficult to determine as annual precipitation conditions also affect the quantity of applied irrigation water. Moreover, the use of the area toll base may conceal discrepancies in the acre-foot cost of water used for irrigating different crops.

Although the use of an acre-foot water toll base may entail additional supervisory and measurement costs to the individual district, this appears

warranted in light of the avoidance of hidden cost discrepancies and the increasing competition for water throughout the state. It may be expected that these northern irrigation districts presently using the area water toll base will shift to an acre-foot base as this competition becomes more apparent.[1/]

Contract Stipulations

The growing number of water supply contracts during the 1950's has been repeatedly mentioned. Their number may be expected to expand in the future as the state of California undertakes various phases of the California Water Plan. These contracts impose pricing limitations on the recipient district. Under current contracts for Central Valley Project water, the price charged by the district for water exported cannot exceed the original price paid.

Were the prices districts charge for exported water unrestricted, profits from this function could be used to reduce member payments. This would tend to result in district water use with a value of marginal product less than waters' marginal unit cost to the district. Current restriction in Bureau of Reclamation contracts essentially prohibit the district from acting as a retailing agency with separated markets, one of which is preferred. Clearly, price differentiation under such circumstances could result in inefficient water use and a reduction in aggregate real income.

This problem is not so apt to occur with noncontracting districts. They generally have adapted their boundaries to the available water supply, and possible jeopardization of water rights precludes their participation in any very large-scale water export activities. Contract water, on the other hand, is secured for the duration of the contract. This currently runs for 40 years with

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1/ The following irrigation districts shifted from an area to volume unit water toll base between 1950 and 1956: San Ysidro, Tulare, Beaumont, Empire West Side, Lower Tule River, and Porterville. Information from the files of the California Districts Securities Commission, Sacramento, California.

possibilities for renewal at that time. Such retailing by the district throughout a region larger than the district itself is contrary to the policy of both the state of California and the Bureau of Reclamation. Intradistrict allocation, on the other hand, is left to the individual contracting entity. Were districts to function as a regional distributive agency, the adequacy of their delivery quotas could not be determined by objective criteria. The tendency would be for each district to overapply for water for resale in the course of contract negotiations.

If unrestricted export water pricing would open the door to unjustifiable reductions in water costs to members, so too might unrestricted pricing of water to members lead to the accrual of surpluses used to underwrite other district functions in themselves economically unwarranted. In the past, the effective articulation of the least-cost water philosophy generally espoused by district members has precluded this. It is not inconceivable that in the future such situations might arise accompanying the assumption of additional district activities and expansion of the district administrative structure. Under these circumstances, a resale ceiling on district sales of contract water to members may be desirable.

The California Districts Securities Commission--A Key Agency?

The California Districts Securities Commission is the principle state regulatory agency for California irrigation districts. Its legal responsibility includes the duties of its predecessor, the California Bond Certification Commission, and pertains specifically to the certification of district bond issues and the maintenance of records of the activities of irrigation districts and their financial condition. Although it has functioned in both of these respects in the past, published accounts reveal little activity by the Commission in suggesting and furthering positive proposals for irrigation district policy. Its legal authority, however, appears to render it capable of so doing.

The California Districts Securities Commission could be a key agency in securing implementation of the recommendations made above in spite of apparent limitations in its recourse to enforcement measures. As its approval must be secured prior to the issuance of district bonds, its persuasive potential is not negligible.

Initial action could be directed toward the clarification and specification of the vague system of district accounts currently prescribed in the California Water Code. Standard data collection forms have been used by the Commission since its inception in 1930, but no set of general accounting definitions have been provided the districts. Such action by the Commission would appear within its designated legal function of record maintenance.

With respect to the assessed valuation procedures, here again the Commission appears as the appropriate agency for implementation. The adoption of such practices would assess beneficiaries proportionately to the benefits received which, in essence, strengthens the financial position of the irrigation district and, thus, the equity behind their bond issues. As the certification of district bonds is intended to assure adequate equity, such a recommendation would appear to be legally and properly within the Commission's jurisdiction. Although land sales data are not now maintained by districts, no immediate adoption of this suggested base for assessed valuation would be possible. The immediate maintenance of such records would facilitate its future adoption and in lieu of regional figures, state computations made by the U. S. Department of Agriculture[1/] could be employed to modify present valuation methods.

The recommended assessed valuation base has proceeded from analysis of the economic consequences of currently used bases. The problem of implementation, however, must be viewed from a broader context. The duplicative effort and added

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1/ For estimates of value per acre of irrigated land used for growing specified crops in California, see U. S. Department of Agriculture, Agricultural Research Service, Current Developments in the Farm Real Estate Market (Washington, May, 1958), p. 8. ARS 43-74 (CD-49).

expense of valuing a single land parcel according to several sets of criteria for taxation by various agencies--county, city, township, district, etc.--is undesirable. One way in which this may be avoided is to employ a single set of criteria for valuation to which rates of levy for these various units of government are applied. An appropriate agency to undertake such valuation is the county which has full facilities, staff, board of equalization, and legal power to perform this function. Its size would also tend to reduce the influence of local interest groups in the valuation procedure as compared with valuation by a district.

It is not clear whether a further fragmentation of the entire assessment problem would result from district adoption of the valuation base here suggested. Possibly the experience gained by district adoption of such a procedure would facilitate its adoption by the county. If such is determined to be the case, the California Districts Securities Commission would appear as an important agency in securing its adoption.

With respect to the suggested contract stipulations, the Commission again would appear as a legally endowed agency that could actively participate in negotiations with the Bureau of Reclamation or the state of California. In the past, the Irrigation Districts Association has served as an unofficial spokesman of the districts, but its private status precludes its active participation in actual negotiations.

The adoption of the acre-foot as a water toll base, on the other hand, is an issue in which the Districts Securities Commission is handicapped in furthering. The most expeditious manner in securing the adoption of this base would appear to be for the California Water Rights Board to declare that because of its tendency toward inefficient water use by district members, continued use of the per-acre-irrigated base for the water toll is contrary to public interest. To further emphasize the inconsistency between this type of practice and water

conservation, the question of whether its continued employment departs from the principle of due diligence in water use might be raised by the Board.

Ascertaining the probability of such changes being incorporated into the current institutional fabric of water organizations is difficult. The empirical potency of California irrigation interests, manifest in public water districts and mobilized by their association, is considerable. One might argue that it would be employed to preserve the latitude they now enjoy in determining pricing behavior. On the other hand, one may anticipate growing public pressure to constrain this latitude, as water demand increases and the higher cost of future water development is acknowledged. It is hoped that if limitations are made at the present time, which minimize the chance of clearly inefficient water use, sufficient flexibility will be retained to permit the public water district to use pricing as a means of satisfying internal policy criteria. Too frequently, a reluctance to modest limitation has led to the imposition of stringent regulation. Were this to occur to California irrigation districts, their pricing flexibility would be impaired. This would seriously limit their adaptability and jeopardize a continuation of the material contribution they have made to the California agricultural economy in the past.